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ABSTRACT

Communication skills, language abilities, and educational achievement of 163 subjects from six residential schools for deaf students were studied. Subjects were tested yearly from 1963 to 1967 on speechreading, fingerspelling, speech intelligibility, reading achievement, arithmetic achievement, and written language. Both males and females and the combined group showed significant improvement in all areas except speech intelligibility, speechreading, and vocabulary usage. Females were consistently superior in receptive communication ability, reading achievement, and most language ability measures. No differences between the sexes were found any year in arithmetic ability or in educational achievement in the last 2 years of the study. For both sexes, growth in educational achievement ranged from one-third grade per year in reading and language to one-half grade per year in arithmetic. In 1963, the average subject showed a battery median of four grades lower than the average non-deaf student. In 1967, battery medians were nearly 6 grades below the Stanford Achievement Test norms. (Author/KW)

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University of Illinois
1970

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ABSTRACT

The communication skills, language abilities, and educational achievement of 163 Ss from six residential schools for deaf students were studied in a reexamination of data reported by Quigley (1969). The Ss were tested each year from 1963 to 1967 on Speechreading; Fingerspelling; Speech Intelligibility; Reading Achievement; Arithmetic Achievement; and Written Language. The scores for each sex, and for the combined sexes, were analyzed for hypothesized differences: (a) across the years for both sexes combined: (b) across the years for each sex separately; and (c) between the sexes each year. Both the separate sexes and the combined group showed significant improvement across the years on all variables with the exception of three: (a) Speech Intelligibility; (b) Speechreading as measured by the Utley Test of Lipreading (which was discontinued after Year 3); and vocabulary usage as measured by the Type Token Ratio. The results indicated definite and consistent superiority of the females over the males on receptive communication ability; reading achievement; and on most language ability measures. No differences were found between the sexes in any year on arithmetic ability; nor were there differences found between the sexes in educational achievement in the last two years of the study. Growth in educational achievement for both sexes was found to be from one-third grade per year in Reading and Language achievement, to one-half grade per year on Arithmetic achievement. At the beginning of the study, the average S showed a Battery Median of four full grades lower than the average non-deaf student. By the end of the study, the Battery Medians were nearly six grades below the Stanford Achievement Test norms.

A STUDY OF THE GROWTH PATTERNS IN LANGUAGE, COMMUNICATION, AND EDUCATIONAL ACHIEVEMENT IN SIX RESIDENTIAL SCHOOLS FOR DEAF STUDENTS

Objectives of the Study

The objective of the present study was to determine the growth rate on selected variables over the five year period for all subjects for whom four full years of data were obtained in the study reported by Quigley (1969), and to compare the progress made by males with that of females over the same period of time. Subjects for whom data were incomplete, or who were dropped from the study before Year 5, were excluded, and method of instruction was eliminated as the dependent variable. Data for all schools were combined for each year, and the pooled means, dichotomized by sex, were plotted to show the growth year by year for each sex separately and for both sexes combined. As will be discussed in the Results section, a high degree of consistency was found between the overall rate of the subjects in the study and the growth rates reported by other investigators in recent publications.

It is not the intent of the authors to review in detail the literature which has been published on the educational development of deaf students. Readers interested in the historical antecedents of the problem will find several summaries in recent publications, among them the Quigley (1969) report on the results of the four-year study from which the data for the present study were adapted; the report of the Babbidge committee (Education of the Deaf, 1965); Hester's report on school leavers (1963); similar reports by Boatner (1965) and Furth (1966); and Gentile's (1969) report on achievement test scores of hearing-impaired students. An examination of the literature, however, does show that there is a common theme running throughout all of the reports: deaf

students are not achieving as well as students of comparable ages who have normal hearing. While there has been considerable discussion about the validity of the test instruments used to measure the achievement of deaf students when such test instruments are those standardized on students with normal hearing (Quigley, 1963, and Wrightstone et al, 1963) other tests have more or less been adapted for use with deaf subjects (Moores, 1967), and, from all indications, show the same phenomenon: most deaf students are leaving school with educational achievement levels of fifth grade or below, and are reading at grade levels even lower than their overall achievement levels.

If one considers the average length of time a deaf student spends in a specialized educational program to be 12 years, the total amount of progress over the 12 years indicates that deaf students advance less than a half-grade per year in overall educational achievement, and less than a third of a grade in reading. In addition, it is quite possible that most of this achievement is attained during the first few years of schooling, with progress leveling off in later years -- the "plateau" phenomenon reported upon by several investigators -- among them Furth (1966), who found that between the ages of 11 and 16, a period of six years, his subjects advanced less than one grade in reading level. If one examines the tables given in the Gentile (1969) report, it will also be seen that during the years when the child is from 7 to 11 years of age, there is slow but steady progress in reading achievement as measured by the mean grade equivalents, but from 11 to 15, progress comes to a standstill or declines. It was hoped that the present study would shed some light on this particular plateau phenomenon.

Statement of Hypotheses

The hypotheses tested in the present study were: (a) there would be

significant changes in growth rate for both sexes, and for the combined N across the four years of the study; and (b) there would be significant differences between the sexes on most of the experimental variables throughout the study.

Selection and Description of Subjects

Selection of the Subjects

In the original study (Quigley, 1969), nine residential schools for deaf students were selected initially for participation in the project. Three of the schools were those systematically employing the Rochester Method of instruction in teaching their students, while the other six, used as comparison schools, employed non-Rochester methods. As was detailed in the Quigley report, three of the comparison schools were later found to be superfluous and dropped from the study, leaving six schools with a total sample population of 223 subjects. All of the 223 subjects remaining after elimination of the three comparison schools were prelingually deaf (age at onset of deafness was under 3½ years); profoundly deaf (at least 75 decibel hearing loss, ASA, in the better ear); and had IQs of at least 80 on the performance scales of the WAIS or the WISC.

For the purpose of the present study, it was decided to select from the original sample population, with ten exceptions in Year 1, only those subjects for whom four full years of data had been obtained. This necessitated the elimination of data obtained on subjects who subsequently became mortalities before the end of the four years as well as those for whom some data were not obtained in certain years due to illness and other factors. Since no attempt was to be made to categorize the results by the variable critical to the original study -- method of instruction -- the data were pooled, and the only dichotomizing employed was that of sex, a procedure not employed in the original study.

Description of the Subjects

As can be seen from Table 1, there were 76 males and 77 females for whom data were obtained in Year 1, making a total sample of 153 subjects for the first year of the study. This was increased to 83 males and 80 females in the second year and all subsequent years by the addition of 10 Ss for whom complete data were obtained for Years 2 through 5, making a total sample of 163 subjects. The average age of the Ss was 12.6 years when the study began, and 16.5 years when it ended. Average IQ was 105.2 in Year 1, and did not change in subsequent years despite the addition of the 10 Ss in Year 2. The Ss had mean Hearing Threshold Level, 500-2000 Hz (ASA), of 88.9, and average age at onset of hearing impairment was 15.7 months after Year 2. The average S of the study had completed 7.7 years of schooling when the study began.

Procedures of the Study

The procedures employed in measuring the experimental variables, and collecting and scoring the data in the present study were those used in the original study by Quigley (1969). To summarize, the experimental variables were measured each year by means of tests administered in the Fall. The variables were classed into three general categories: (a) Communication Ability, which included speechreading, receptive fingerspelling, and speech intelligibility; (b) Language Ability, which included reading, language, and written language; and (c) Educational Achievement, which included the reading and language scores again, and arithmetic ability, all of which were measured by five of the sub-tests of the Stanford Achievement Test Batteries, Form N. Each variable was tested by means of the best available instrument, and in one case, a substitute test was introduced in the second year of the study when the original test proved to be too difficult. In addition, "Cloze" procedures

TABLE 1

Means and Standard Deviations for Descriptive Variables for Each Year, by Sex

	N = 153		N = 163		N = 163		N = 163		N = 163	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Age of subject (in years)										
Male	12.4	1.58	13.3	1.76	14.3	1.76	15.3	1.76	16.3	1.76
Female	12.7	1.70	13.6	1.81	14.6	1.81	15.6	1.81	16.6	1.81
Group	12.6	1.63	13.5	1.79	14.5	1.79	15.5	1.79	16.5	1.79
I.Q.										
Male	105.9	11.39	106.2	11.40	106.2	11.40	106.2	11.40	106.2	11.40
Female	104.4	13.27	104.3	13.20	104.3	13.20	104.3	13.20	104.3	13.20
Group	105.2	12.41	105.2	12.28	105.2	12.28	105.2	12.28	105.2	12.28
Years of previous schooling										
Male	7.5	2.14	8.4	2.28	9.4	2.28	10.4	2.28	11.4	2.30
Female	7.8	2.25	8.7	2.36	9.7	2.36	10.7	2.36	11.7	2.39
Group	7.7	2.11	8.5	2.34	9.5	2.34	10.5	2.34	11.5	2.36
Hearing Threshold Level (in dB, ASA)										
Male	89.2	9.15	89.0	9.10	89.0	9.10	89.0	9.10	89.0	9.10
Female	88.7	12.11	88.7	12.11	88.7	12.11	88.7	12.11	88.7	12.11
Group	88.9	7.78	88.9	10.72	88.9	10.72	88.9	10.72	88.9	10.72
Age at onset of deafness (in months)										
Male	16.0	7.55	15.4	9.23	15.4	9.23	15.4	9.23	15.4	9.23
Female	15.4	9.23	15.9	7.71	15.9	7.71	15.9	7.71	15.9	7.71
Group	15.8	8.17	15.7	8.22	15.7	8.22	15.7	8.22	15.7	8.22

were introduced in the final year in an effort to gain a further index of ability, but are not considered in the present study.

The data for the original study were collected from available school records and from the testing conducted by the investigator or other personnel connected with the project, and involved both group and individual testing. The procedures employed in analyzing the data in the present study differed somewhat from those employed in the original, both in type of statistic selected, and in years selected for correlational analysis.

Measurement of Experimental Variables

Communication ability. Communication Ability, which included: (a) speech intelligibility; (b) speechreading; and (c) the receptive fingerspelling ability, was tested by various measures. Speech intelligibility was assessed by subjecting samples of the subjects' speech (taped while the subject was reading from lists of phonetically balanced words) to independent, trained listeners on the staff of the Institute for Research on Exceptional Children. Speech-reading ability, during the first year, was assessed by means of the Utley Test of Lipreading (Utley, 1964), Form A. This test proved to be a difficult one for deaf children; therefore, in the second year, it was augmented by the Word and Sentence versions of the Craig Lipreading Inventory (Craig, 1964). The three tests were administered concurrently until the third year of the study after which the Utley test was discontinued. Fingerspelling ability was assessed by means of a filmed test prepared by Quigley and Frisina (1961), which had been adapted from the Utley Test of Lipreading, Form B.

Language ability. Language Ability was assessed by means of the reading and language sub-tests of the Stanford Achievement Test batteries, and analyses of samples of written language. Written language samples were

obtained from the subjects each year by presenting them with a number of cartoon sequences and requiring them to write stories about each sequence, and the samples thus obtained were analyzed for (a) Language Productivity (Total Words Written); (b) Mean Sentence Length; (c) Type Token Ratio; (d) Grammatical Correctness Ratio; (e) Strings Analysis; (f) Subordination Ratio; and (g) Spelling.

Educational achievement. Educational achievement was assessed by administration of the Stanford Achievement Test, Form N, in each year of the study. Of the three batteries employed, only five of the sub-tests were used: Paragraph Meaning; Word Meaning; Language; Arithmetic Reasoning; and Arithmetic Computation. The combined Reading and Arithmetic scores and the Battery Medians were also computed.

Method of Statistical Analysis

All data were punched on IBM cards and analyzed by the IBM 360/75 Computer in the Digital Computer Laboratory at the University of Illinois.

In the original study, two-tailed t-tests were employed to compare the experimental and comparison groups. In the present study, the focus of interest centered on the growth patterns across the four years of the study as well as on differences between the sexes, so the method of statistical analysis differed somewhat. Both one-way and two-way analyses of variance were performed, utilizing both F-tests and t-tests of significance. In addition, the results of the analyses were compared by use of Tukey's Studentized Range Statistic (Tukey, 1957) in an effort to isolate the differences discovered by the analyses. Correlational analyses were also performed, and the correlation coefficients thus obtained were tested for significance. The results of these methods of statistical analysis are discussed later in the report.

Results of the Study

Table 2 gives the means, standard deviations and gains for the experimental variables for each sex, and for the combined sexes for each of the four years of the study. Table 3 gives a summary of the analyses of variances between the sexes for Years 2 through 5, and for the combined sexes across the last four years. Year 1 is not included in Table 3 because it was found that, with the exception of two variables -- Word Meaning, and Combined Reading -- no significant differences were found between the sexes on any of the variables. On the two reading variables mentioned, differences at the .05 level were found between the sexes in Year I. As can be seen from Table 3, highly significant differences were found across the years on all of the experimental variables except three: (a) Speech Intelligibility; (b) Speechreading as measured by the Utley Lipreading Test; and (c) Subordination Ratio. On those three variables, no significant improvement was found between the first and last year each variable was tested, nor among any intervening years.

With one exception, Spelling, the finding of significant improvement across the years for both sexes combined was paralleled by findings of significant improvement across the years for each sex when analyzed separately. On Spelling, however, although the combined sexes improved significantly across the years, when the sexes were analyzed separately, it was found that while the males improved significantly, the females did not. However, this must be interpreted in light of the findings that the males showed poorer performance in Year 2 than in Year 1, while the females maintained a steady rate of improvement. This decline in performance in Year 2 by the males may have accounted for the difference between the sexes on improvement across the years.

In general, it was found that the females outperformed the males on the

TABLE 2

Means, Standard Deviations, and Gains for Experimental Variables by Year: Total Population

	Year 1 N = 153		Year 2 N = 163		Year 3 N = 163		Year 4 N = 163		Year 5 N = 163		Gains	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Total	Mean
Average Age	12.6	1.57	13.5	1.79	14.5	1.79	15.5	1.79	16.5	1.79	3.9	0.98
I.Q.	105.2	12.41	105.2	12.28	105.2	12.28	105.2	12.28	105.2	12.28		
Mental Age	13.3	2.39	14.2	2.61	15.2	2.61	16.2	2.61	17.2	2.61		
Stanford Test Norms	7.5		8.4		9.4		10.4		11.4		3.9	
Communication												
Fingerspelling	53.1	26.39	59.7	27.21	66.3	25.33	73.9	21.87	78.0	19.49	24.9	6.23
Speech	18.0	16.97	22.5	19.20	22.9	18.66	22.1	18.52	22.9	18.69	4.9	1.23
Speechreading												
Utley	13.6	11.83	11.9	9.41	14.3	9.73	n.a.	n.a.	n.a.	n.a.	0.7	0.35
Craig Word	n.a.	n.a.	65.3	17.01	68.0	15.27	70.4	14.88	72.5	13.62	7.2	2.4
Craig Sent.	n.a.	n.a.	57.5	19.67	60.7	20.43	64.6	21.54	68.6	19.37	11.1	3.70
Language												
P.M.	3.4	1.03	3.7	1.15	4.2	1.49	4.4	1.65	4.8	1.82	1.4	0.35
W.M.	3.1	0.82	3.8	1.98	3.8	1.24	4.1	1.44	4.5	1.67	1.4	0.35
Comb. Read.	3.3	0.88	3.6	1.05	4.0	1.31	4.3	1.49	4.6	1.69	1.3	0.35
Language	3.9	1.81	4.5	2.25	5.0	2.65	5.7	2.69	6.2	2.99	2.3	0.58
T.T.R.	51.1	10.27	53.4	8.67	52.9	6.93	55.4	8.21	55.8	6.72	4.7	1.18
M.S.L.	6.7	2.10	7.8	2.83	8.3	3.73	8.7	3.50	9.4	4.14	2.7	0.68
Total Words	60.0	26.72	98.1	18.19	104.6	12.03	102.2	10.73	105.0	6.92	45.0	11.25
Spelling	98.3	0.62	96.9	4.88	97.4	2.43	98.3	1.61	98.3	1.77	0.0	0.00
G.C.R.	80.1	12.19	81.7	9.64	81.9	1.02	85.0	8.79	84.3	8.73	4.2	1.05
Strings	4.4	1.71	4.5	2.06	4.5	1.95	5.1	2.31	5.6	2.67	1.2	.30
Sub. Ratio	n.a.	n.a.	n.a.	n.a.	14.6	11.90	13.9	13.00	11.9	15.47	-2.7	-0.90
Educ. Achievem't												
A.R.	3.6	1.30	4.2	1.62	4.7	1.97	5.1	2.00	5.7	2.18	2.1	0.53
A.C.	4.4	1.26	4.9	1.49	5.3	1.64	5.9	1.85	6.5	2.07	2.1	0.53
Comb. Arith.	4.1	1.24	4.6	1.51	5.0	1.74	5.5	1.89	6.1	2.10	2.1	0.53
Batt. Median	3.5	1.08	4.0	1.39	4.5	1.63	5.0	1.72	5.5	1.96	2.0	0.50

TABLE 3

Overall Results of Analyses of Variance: Between the Sexes by Year, and Across the Years: Total Population, Significant Differences Only: (N = 163 each year)

	Year 2		Year 3		Year 4		Year 5		Across the Years	
	Between Sexes		Between Sexes		Between Sexes		Between Sexes		Total Population	
	F	Prob.	F	Prob.	F	Prob.	F	Prob.	F	Prob.
Communication										
Fingersp.	8.53	.01			3.72	.05	3.95	.05	27.48	.01
Speech										
LR, Utley					n.a.		n.a.			
LR, CW	4.00	.05	4.56	.05			6.77	.01	6.67	.01
LR, CS	5.89	.05					6.36	.05	9.08	.01
Language										
P.M.	5.73	.05							22.16	.01
W.M.			7.01	.01	4.73	.05	5.76	.05	6.47	.01
Comb. Read.	8.50	.01	5.33	.05	3.96	.05	4.64	.05	25.32	.01
Lang.	4.11	.05	9.62	.01	6.76	.01	16.12	.001	15.94	.01
T.T.R.							4.60	.05	8.63	.01
M.S.L.	5.86	.05							13.76	.01
Tot. Wds.	5.45	.05			6.23	.01			218.77	.01
Spelling	3.92	.05	4.29	.05					4.38	.01
G.C.R.	5.45	.05	4.86	.05	7.90	.01	9.16	.01	6.27	.01
Strings	8.65	.01			3.93	.05	4.10	.05	8.81	.01
Sub Rat.	n.a.									
Educ. Ach'mt										
P.M.	5.73	.05							22.16	.01
W.M.			7.01	.01	4.73	.05	5.76	.05	6.47	.01
Comb. Read.	8.50	.01	5.33	.05	3.96	.05	4.64	.05	25.32	.01
Lang.	4.11	.05	9.62	.01	6.76	.01	16.12	.001	15.94	.01
A.R.									29.51	.01
A.C.									36.06	.01
Comb. Arith.									32.28	.01
Batt. Med.	5.97	.05	4.60	.05					18.35	.01

majority of the variables in most years, although the differences between the sexes did not always reach the statistically significant level of .05. Most of the significant differences were found between the sexes in Year 2, with Year 5 second. The least number of significant differences between the sexes were found in Year 1, as was mentioned earlier, in which differences were found at the .05 level of significance on only two variables -- Word Meaning, and Combined Reading. No significant differences were found between the sexes in any year on: (a) Speech Intelligibility; (b) the Utley test of speechreading ability; (c) Subordination Ratio; nor (d) any of the arithmetic sub-tests of the Stanford Achievement Test. In Year 2, in addition to the variables mentioned above, no significant differences were found between the sexes on: (a) Word Meaning and (b) Type Token Ratio. In Year 3, no significant differences were found between the sexes on: (a) Fingerspelling Ability; (b) the sentence version of the Craig Lipreading Inventory; (c) Paragraph Meaning; (d) Type Token Ratio; (e) Mean Sentence Length; (f) Language productivity as measured by Total Words Written; and (g) Strings Analysis. In Year 4, no significant differences were found between the sexes on: (a) any of the measures of speechreading ability; (b) Paragraph Meaning; (c) Type Token Ratio; (d) Mean Sentence Length; (e) Spelling; and (f) the Battery Medians on the Stanford test. Year 5 was marked by findings of significance on more variables than in the preceding two years, although there were again found to be no significant differences between the sexes on: (a) Paragraph Meaning; (b) Mean Sentence Length; (c) Spelling; and (d) Battery Medians; and, in addition, (e) Total Words Written.

Other than the above mentioned exceptions, the differences between the sexes were all of statistical significance, and showed the females to be superior to the males in performance.

Analyses of the Data

Communication variables. Table 4 gives a summary of the analysis of variance on the expressive communication skills of Fingerspelling and Speech Intelligibility. It can be seen that both sexes improved significantly in their ability to read fingerspelled words across the years, and that the females were significantly superior in this to the males. Figure 1 illustrates the difference in performance between the sexes. In the ability to speak intelligibly, however, neither the combined sexes nor the separate sexes improved significantly across the years. In other words, the males and females could speak no more intelligibly at the end of the study than they could at the beginning regardless of the amount of training they received in between, if any. On this variable, contrary to the general trend, the males outperformed the females in most years. Year 4, however, was characterized by a reversal in performance in that the females did better than the males (Figure 2) although in no year did the difference in performance reach statistical significance.

Table 5 summarizes the results of the analyses of variance on the receptive communication skill of speechreading as measured by the Utley test and the two Craig tests. As can be seen also from Figures 3, 4, and 5, the females performed significantly better than the males on all measures of speechreading ability, however, only on the two Craig tests did the combined sexes show significant improvement across the years. It can also be seen from the figures that a wide discrepancy existed in performance between the Utley test and the two Craig tests, which illustrates the relative difficulty of the Utley test for deaf children.

Language variables. Table 6 gives a summary of the results of the analysis

TABLE 4

Summary of Analysis of Variance:
Communication Skills (Fingerspelling and Speech Intelligibility)

Variable	Source of Variation	DF	Sum of Squares	Mean Square	F	Probability of a Larger F
Fingerspelling	Year	4	6.3244	1.5811	27.48	<.01
	Sex	1	1.2804	1.2804	22.26	<.01
	Year and Sex	4	.1047	n.s.		
	Within	764	43.9518			
	Total	773	51.6613			
Speech Intelligibility	Sex	4	.2233	n.s.		
	Year	1	.1191	n.s.		
	Sex and Year	4	.2825	n.s.		
	Within	655	21.5855			
	Total	664	22.2104			

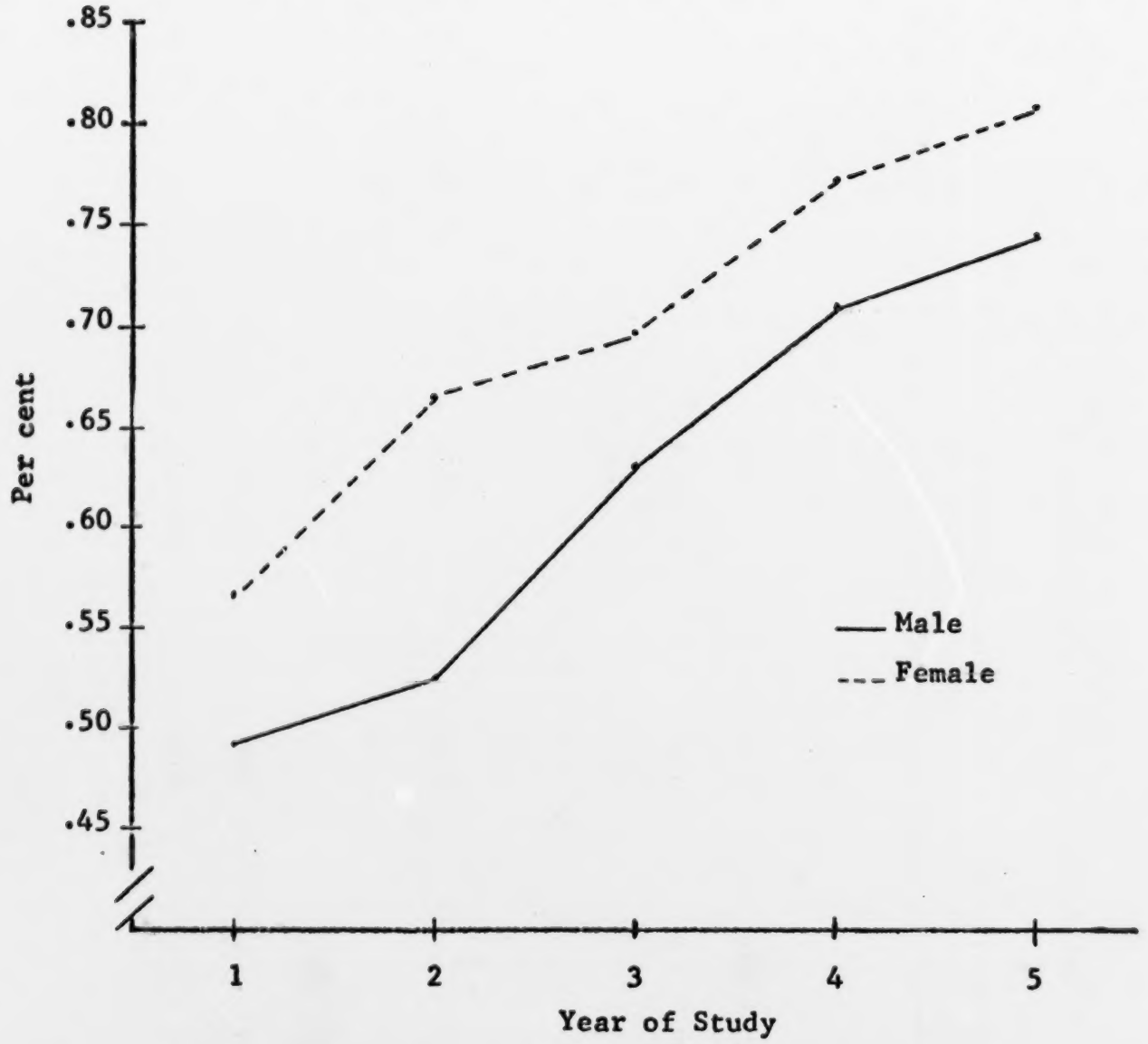

Figure 1. Fingerspelling: Mean per cent of correctly identified fingerspelled words scored by each sex in each year.

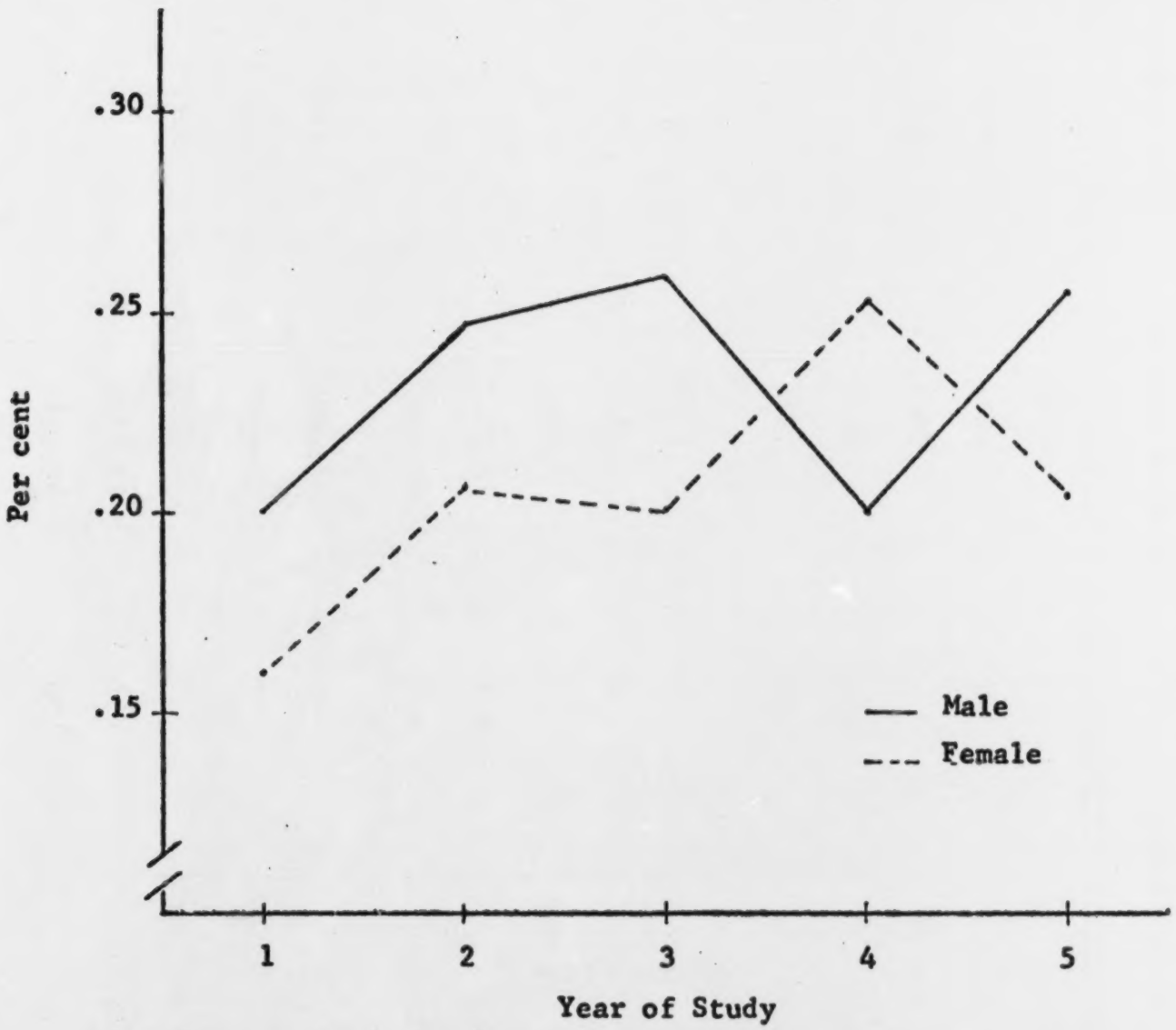

Figure 2. Speech: Mean per cent of intelligible words spoken by each sex in each year.

TABLE 5

Summary of Analyses of Variance:
Receptive Communication Skills (Speechreadings)

Variable	Source of Variation	DF	Sum of Squares	Mean Square	F	Probability of a Larger F
Speechreading Utley	Year	2	.0418	n.s.		
	Sex	1	.0631	.0631	6.05	<.01
	Year and Sex	2	.0054	n.s.		
	Within	404	.0421			
	Total	409	.1524			
Speechreading Craig Word	Year	3	.4529	.1510	6.67	<.01
	Sex	1	.3147	.3147	13.90	<.01
	Year and Sex	3	.0354	n.s.		
	Within	615	13.9177			
	Total	622	14.7207			
Speechreading Craig Sentence	Year	3	1.1063	.3688	9.08	<.01
	Sex	1	.6572	.6572	16.18	<.01
	Year and Sex	3	.0335	n.s.		
	Within	621	28.2260			
	Total	628	30.0230			

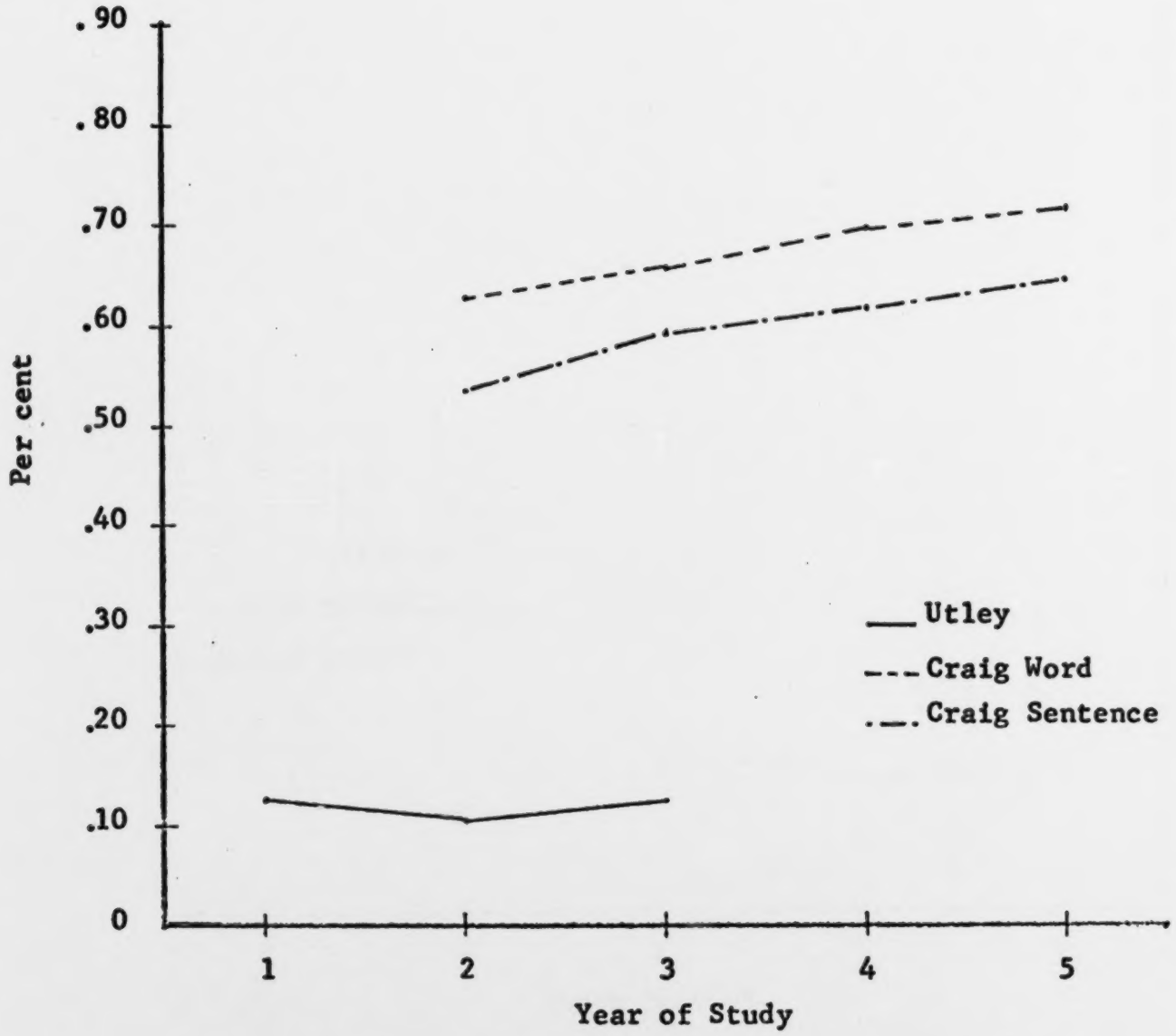

Figure 3. Speechreading, males: Mean per cent of correctly identified spoken words or sentences in each year on each of the three tests of speechreading ability.

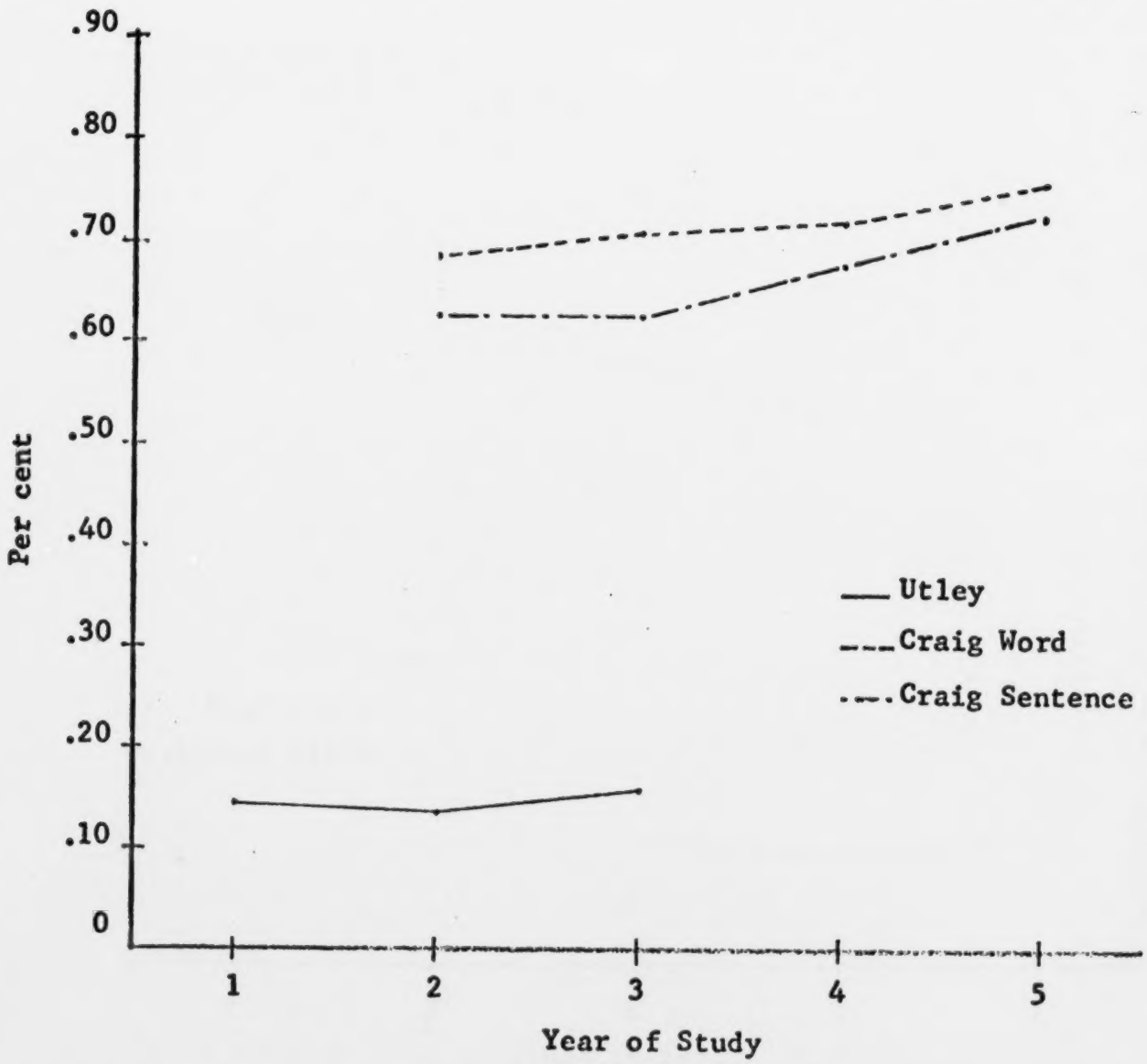

Figure 4. Speechreading, females: Mean per cent of correctly identified spoken words or sentences in each year on each of the three tests of speechreading ability.

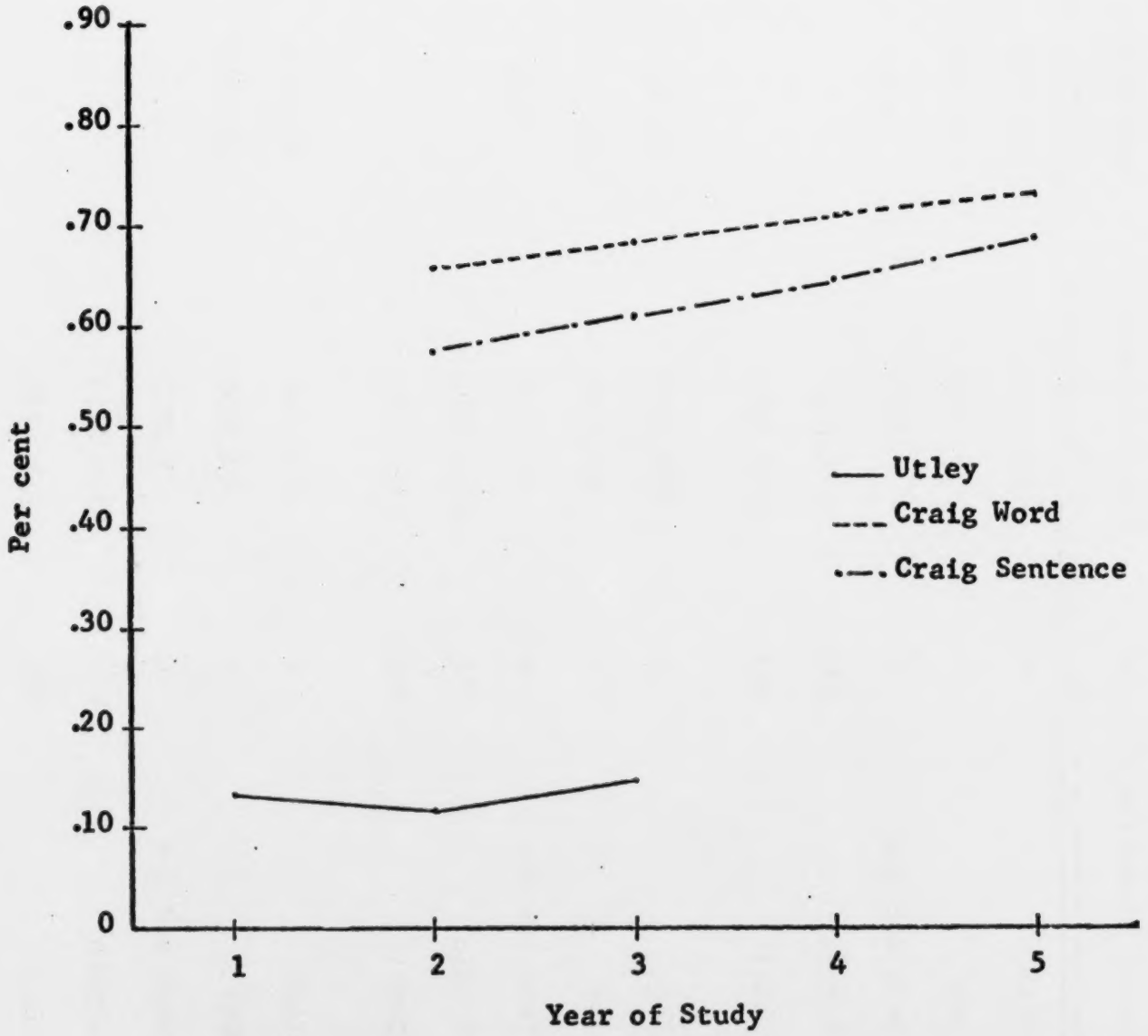

Figure 5. Speechreading, combined sexes: Mean per cent of correctly identified spoken words or sentences in each year for each of the three tests of speechreading ability.

TABLE 6

Summary of Analyses of Variance:
Reading Variables

Variable	Source of Variation	DF	Sum of Squares	Mean Square	F	Probability of a Larger F
Paragraph Meaning	Year	4	185.3616	46.3404	22.16	<.01
	Sex	1	38.1490	38.1490	18.25	<.01
	Year and Sex	4	.5525	n.s.		
	Within	778	1626.6441			
	Total	787	1850.7072			
Word Meaning	Year	4	160.0699	40.0175	6.47	<.01
	Sex	1	81.2119	81.2119	13.13	<.01
	Year and Sex	4	24.7844	n.s.		
	Within	776	4800.4294			
	Total	785	5066.4956			
Combined Reading	Year	4	171.6704	42.9176	25.32	<.01
	Sex	1	40.8696	40.8696	24.11	<.01
	Year and Sex	4	1.3812	n.s.		
	Within	777	1317.0154			
	Total	786	1530.9366			

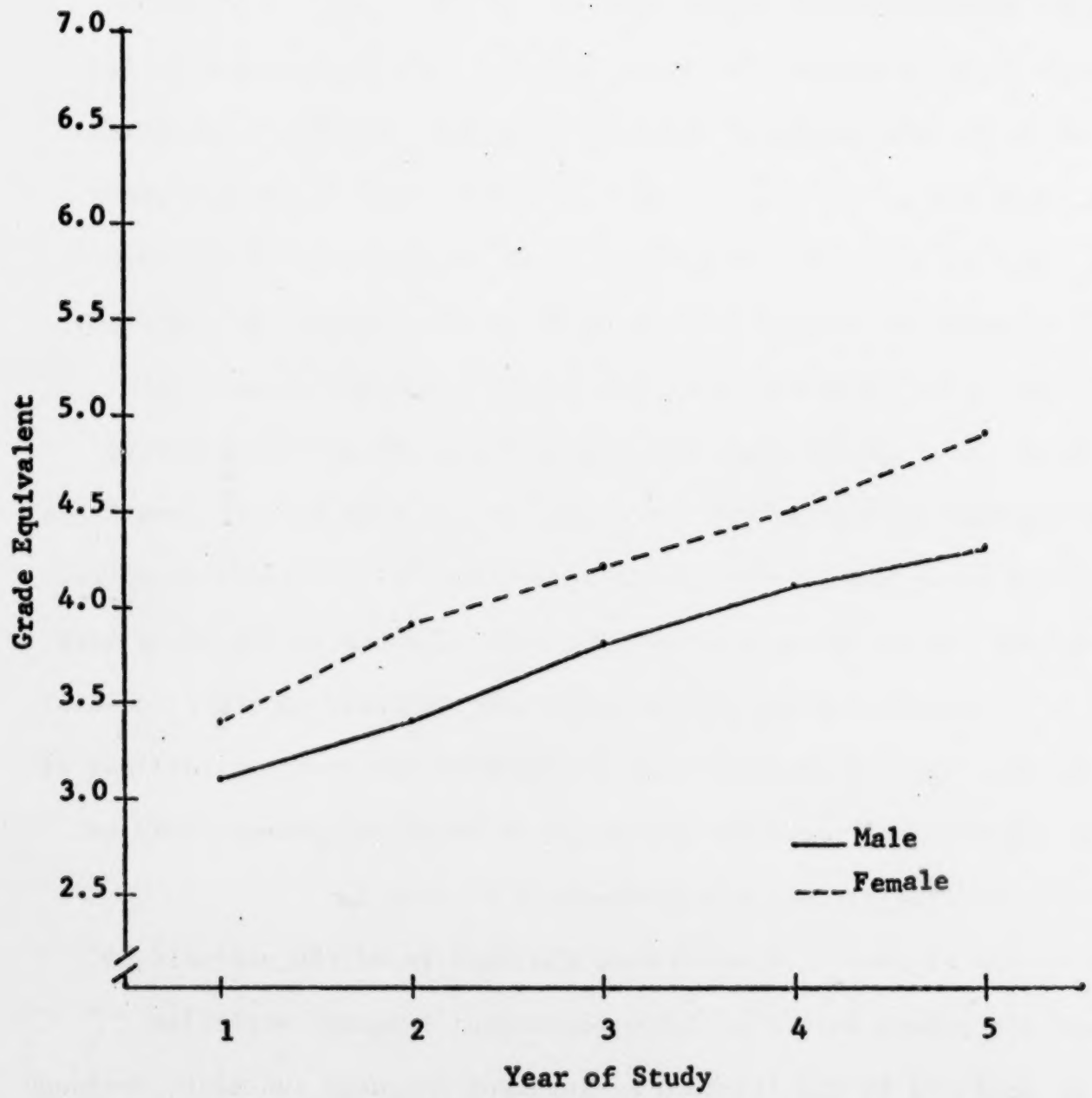

Figure 6. Combined Reading: Mean grade equivalent scores in each year for each sex on the combined Paragraph Meaning and Word Meaning sub-tests of the Stanford Achievement Test, Form N.

of variance among the reading sub-tests of the Stanford Achievement Test; Paragraph Meaning and Word Meaning; and the average of the scores on two reading variables; Combined Reading. As can be seen from the growth curves shown in Figure 6, the females again outperformed the males in average reading ability, with the differences significant at the .01 level. Both sexes improved significantly across the years, although this improvement is far smaller than would be expected of non-deaf students. It will be recalled that the average age of the subjects in Year 1 was found to be 12.6 years, and if one compares the grade achievement norms on the Standard Achievement Test (Table 2) with the average reading level of the subjects in the study, it will be found that there was more than a four-grade gap between the average reading level of the deaf subjects in the study and the expected norms of a non-deaf student of the same age. It can also be seen from Table 2 that this gap increased at the rate of approximately two-thirds grade per year, and by the end of the four years, the deaf students in the study were reading at a level nearly seven grades below that expected of their non-deaf peers of the same age. Therefore, what improvement was found, regardless of statistical significance, must be considered to be an improvement only on the subjects' baseline performance as measured in Year 1.

Table 7, and Figures 7, 8 and 9 show the results of the analysis of variance and the growth curves on three additional language variables: Language, as measured by the Stanford Achievement Language sub-test; Language Productivity, as measured by the total number of words written in samples of written language obtained from the subjects; and Mean Sentence Length, also obtained from the written language samples. As on most language variables, the females did better than the males on the Language sub-test of the Stanford.

TABLE 7

Summary of Analyses of Variance:
Language, Language Productivity, and Mean Sentence Length

Variable	Source of Variation	DF	Sum of Squares	Mean Square	F	Probability of a Larger F
Language	Year	4	398.7005	99.6751	15.94	<.01
	Sex	1	206.5188	206.5188	33.02	<.01
	Year and Sex	4	28.3476	n.s.		
	Within	632	3953.0779			
	Total	641	4585.9448			
Language Productivity (Total words written)	Year	4	228351.7900	57087.9480	217.77	<.01
	Sex	1	2698.8905	2698.8905	10.30	<.01
	Year and Sex	4	1783.9415	n.s.		
	Within	767	201071.6900			
	Total	776	433906.3120			
Mean Sentence Length	Year	4	618.3241	154.5810	13.76	<.01
	Sex	1	1.9188	n.s.		
	Year and Sex	4	59.0391	n.s.		
	Within	767	8617.5603			
	Total	776				

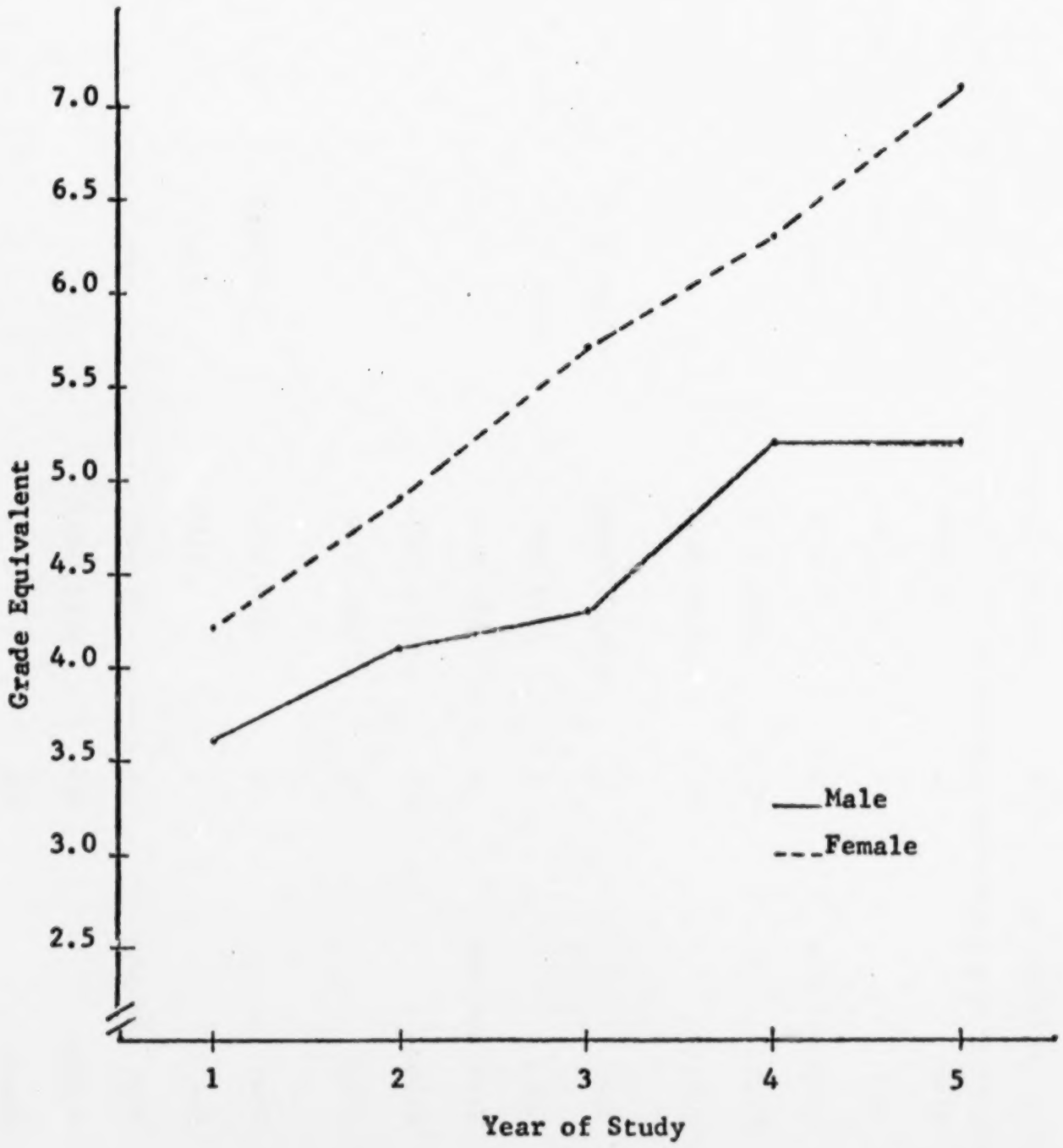

Figure 7. Language: Mean grade equivalent scores in each year for each sex on the Language sub-test of the Stanford Achievement Test, Form N.

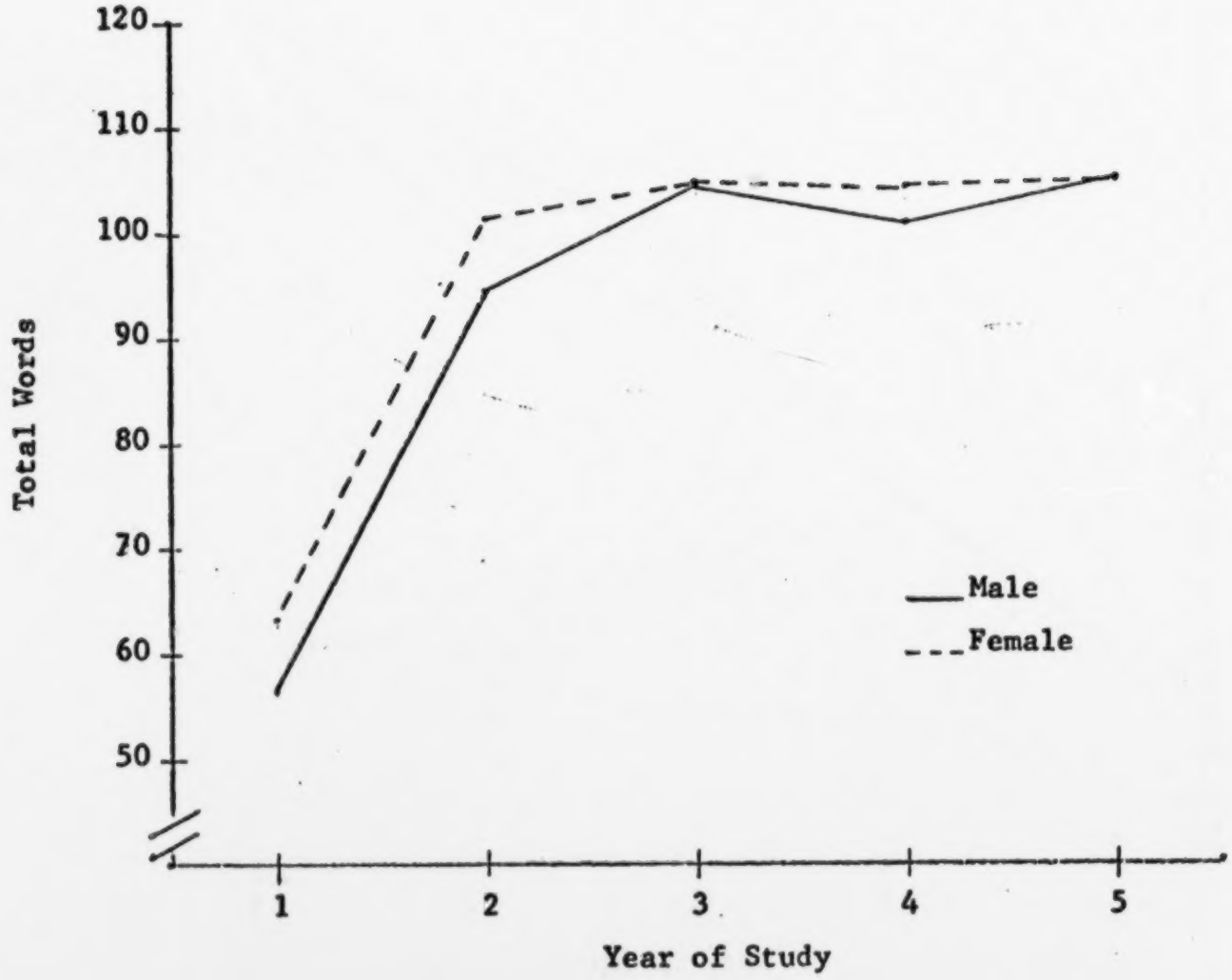

Figure 8. Language Productivity: As measured by the mean total number of words in written language samples obtained from each sex in each year.

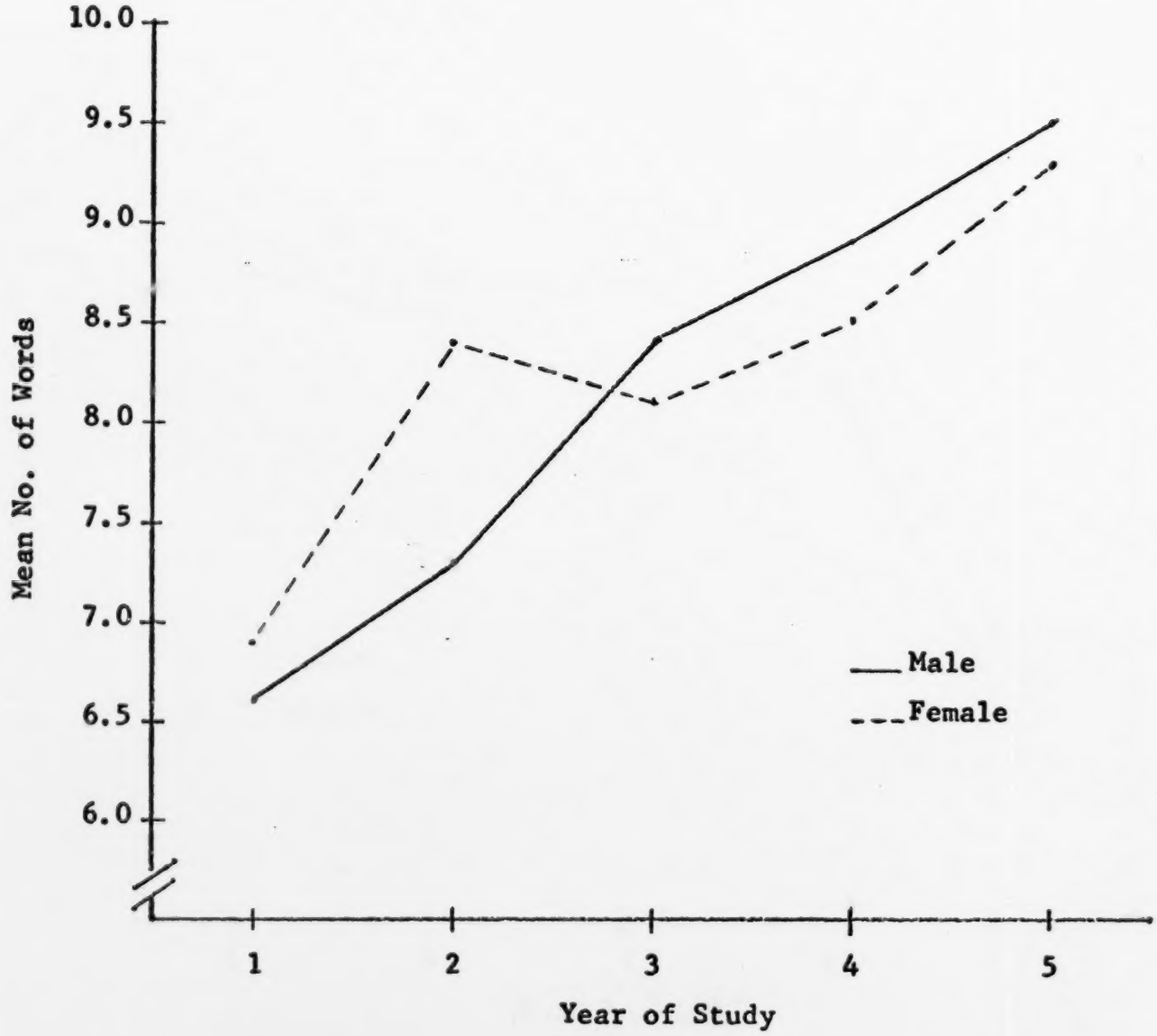

Figure 9. Mean Sentence Length: Mean number of words in sentences written by each sex in each year in language samples.

In addition, both sexes as a group showed significant gains between Years 1 and 5, although the gains must also be considered relevant only for the sample population. Language Productivity showed the greatest increase among all variables for both sexes, especially between Years 1 and 2. Again, the females were more productive than the males in that they wrote longer stories about the test cartoons than did the males, but, as will be discussed later, their language structure was no more complex than that of the males until the fifth year of the study. Except for Year 2, no significant differences were found between the sexes on the length of the sentences written. In Year 2, the females wrote significantly longer sentences than did the males, but from Year 3 to Year 5, the trend had reversed itself and the males wrote longer sentences than did the females, although the differences were not found significant.

Table 8, and Figures 10, 11, and 12 give the results of the analyses of variance and the growth curves on Type Token Ratio, Grammatical Correctness Ratio, and Strings Analysis. The Type Token Ratio, an index of vocabulary usage, was the percentage of different words used in the first 100 in each language sample. It can be seen from Figure 10 that the males initially improved faster than the females, but by Year 4, the females had caught up with and passed the males. Taken as a group, however, the differences between the sexes were not significant across the years, although Year 5 alone showed the females to have used significantly larger vocabularies than the males. Both sexes improved significantly upon their baseline performances across the years by demonstrating larger use of their vocabularies in their written language samples.

Figure 11 shows the growth curves on the Grammatical Correctness Ratio. The amount of improvement shown by the separate sexes, and by the combined sexes, while small, was significant. There were also significant differences between the sexes on this variable, with the females showing a larger

TABLE 8

Summary of Analyses of Variance:
Type Token Ratio, Grammatical Correctness Ratio,
and Strings Analysis

Variable	Source of Variation	DF	Sum of Squares	Mean Square	F	Probability of a Larger F
Type Token Ratio	Year	4	.2338	.0585	8.63	<.01
	Sex	1	.0004	n.s.		
	Year and Sex	4	.0415	n.s.		
	Within	767	5.1921			
	Total	776	435.2315			
Grammatical Correctness Ratio	Year	4	.2423	.0657	6.27	<.01
	Sex	1	.2755	.2755	28.53	<.01
	Year and Sex	4	.0007	n.s.		
	Within	767	7.4068			
	Total	776	7.9253			
Strings Analysis	Year	4	162.7193	40.6798	8.81	<.01
	Sex	1	91.1336	91.1336	19.73	<.01
	Year and Sex	4	8.5344	n.s.		
	Within	768	3546.7642			
	Total	777	3809.1515			

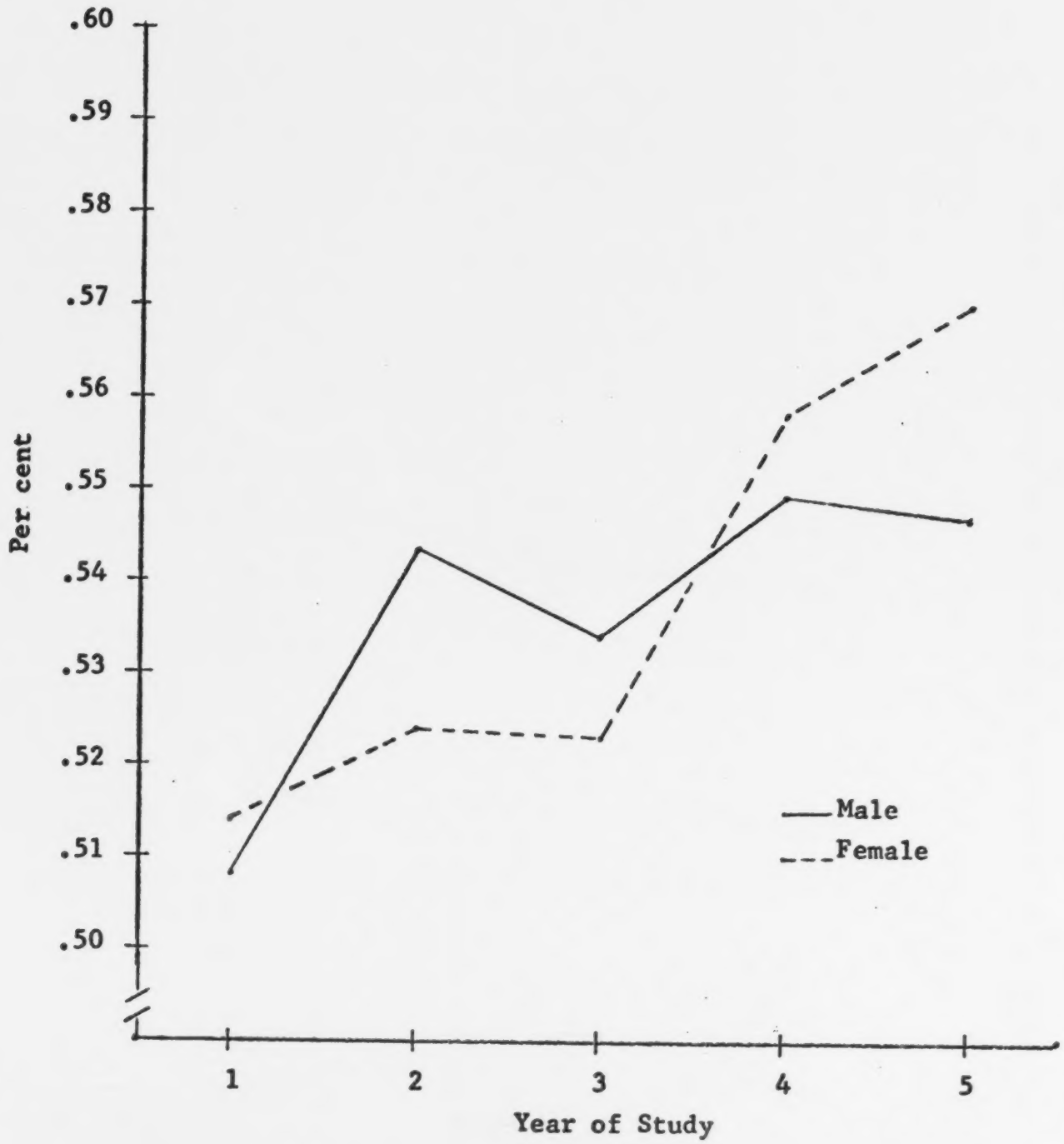

Figure 10. Type Token Ratio: Mean per cent of different words used in each year by each sex out of the first 100 words in the written language samples.

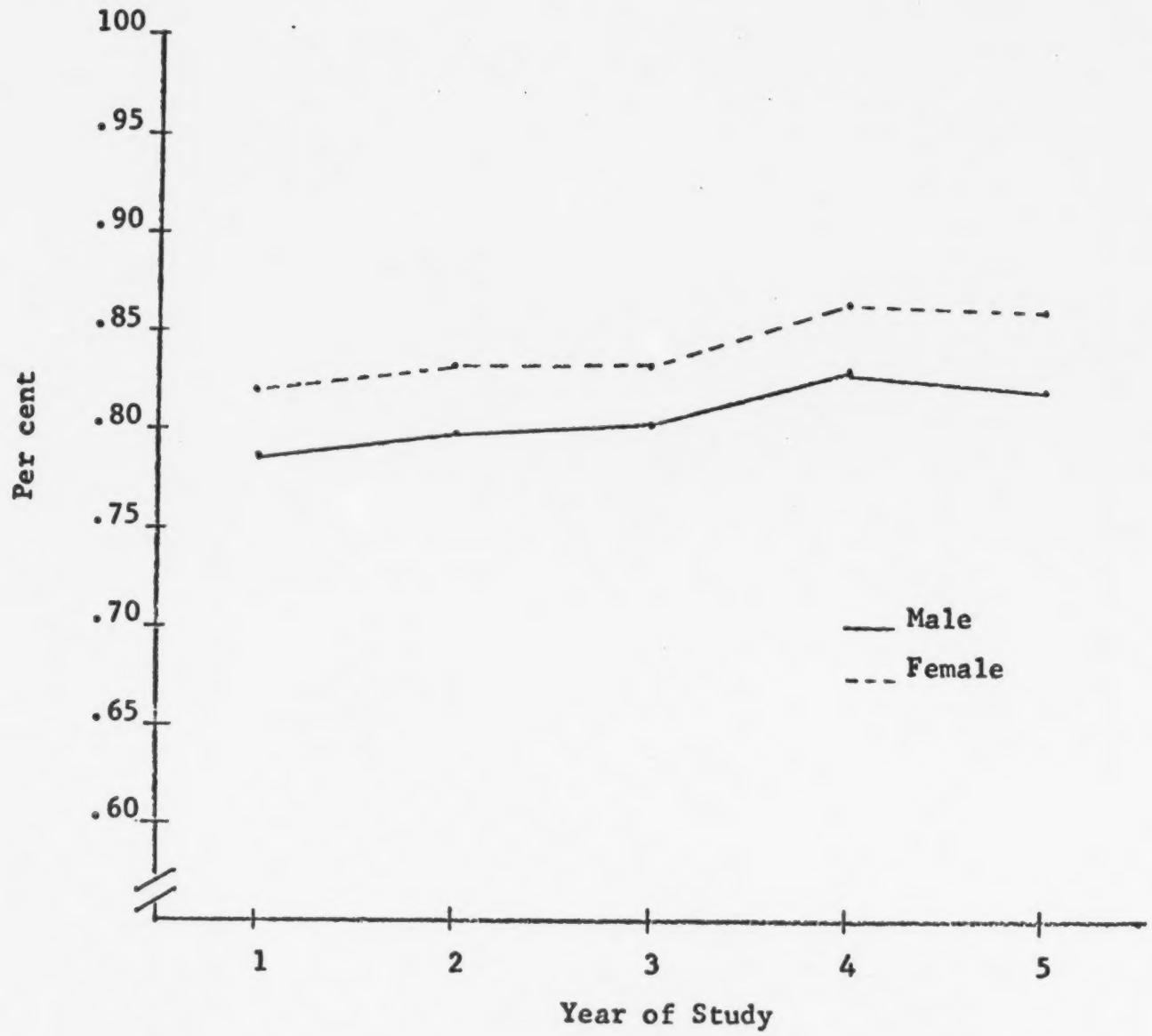

Figure 11. Grammatical Correctness Ratio: Mean per cent of grammatically correct words in the first 100 written by each sex in each year.

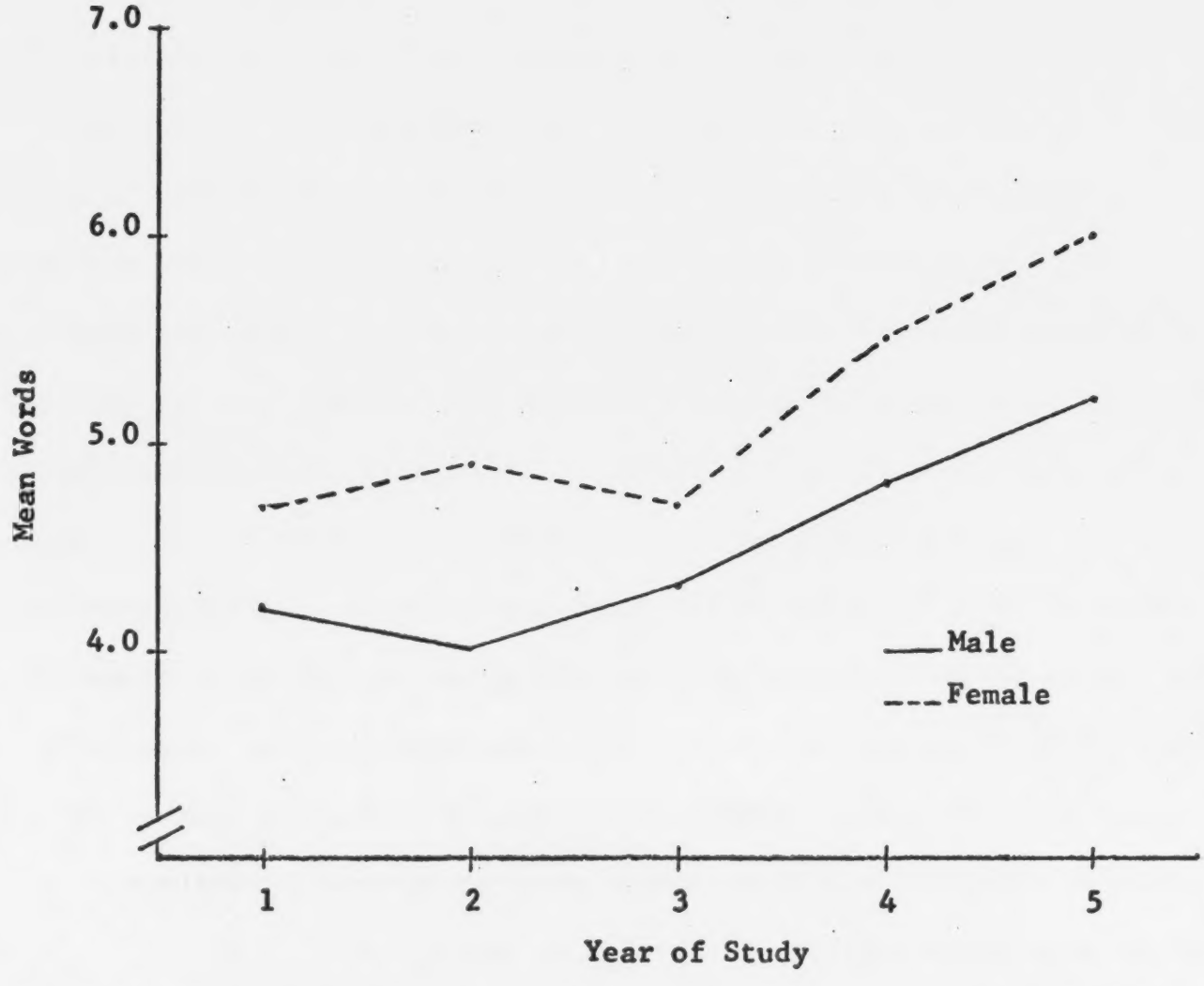

Figure 12. Strings Analysis: Mean number of words per sentence written by each sex which were used in appropriate word order in each year.

percentage of grammatically correct words among the first 100 written in the language samples. Figure 12 shows the growth on Strings Analysis, an index of the mean number of words per sentence which were written in appropriate word order. It will be seen that, in common with most of the other language variables, the females again proved superior to the males in their ability to write sentences with the words arranged in correct sequence.

Table 9 shows the results of the analysis of variance on Subordination Ratio, and Figure 13 illustrates the growth curves. A measure of language complexity, Subordination Ratio data were analyzed for Years 3, 4 and 5 for the present study. As can be seen from Table 9, the combined sexes did not show significant improvement in the percentage of dependent to independent clauses over the last three years of the study, nor were there any significant differences found between the sexes in any year of the three from which data were taken. The lack of increase in the complexity of the language used by the deaf students in the study, insofar as the ratio of dependent to independent clauses can be considered a valid measure of language complexity, would appear to indicate that while the deaf students in the study increased in language productivity, in the length of the sentences written, and in ability to write grammatically correct words in appropriate order, there was apparently no increase in actual language sophistication. Rather, the subjects apparently learned to use more words to construct simple sentences more grammatically, without developing any measurable facility with language per se.

Educational achievement. Table 10 gives a summary of the results of the analyses of variance on the arithmetic variables as measured by the Arithmetic Reasoning and Arithmetic Computation sub-tests of the Stanford Achievement Test, and the computed Combined Arithmetic scores. Figure 14 shows the growth

TABLE 9

Summary of Analyses of Variance:
Subordination Ratio

Variable	Source of Variation	DF	Sum of Squares	Mean Square	F	Probability of a Larger F
Subordination Ratio	Year	2	.0083	n.s.		
Subordination Ratio	Year	2	.0083	n.s.		
	Sex	1	.0011	n.s.		
	Year and Sex	2	.1003	n.s.		
	Within	154	.0337			
	Total	159	.1434			

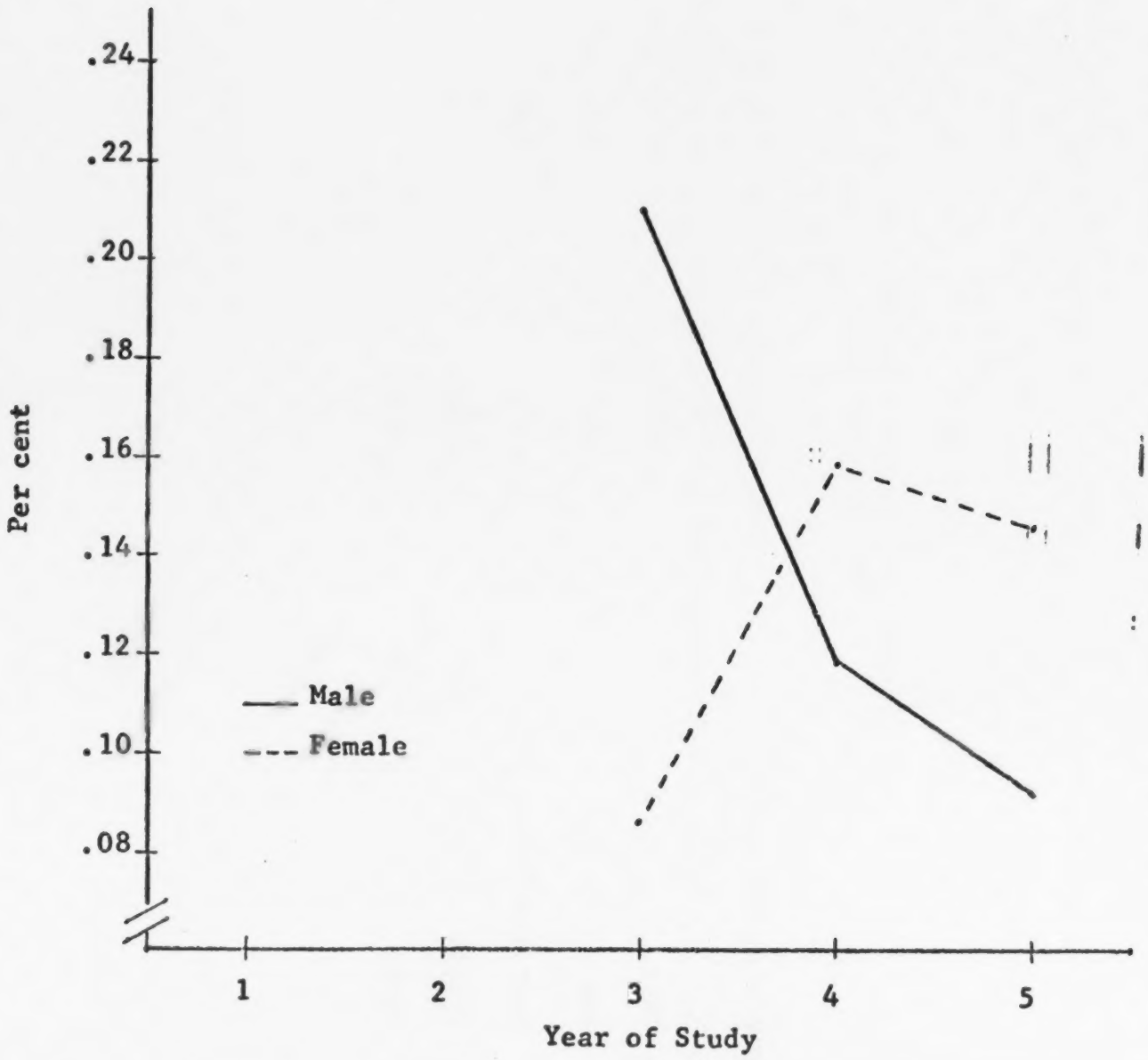

Figure 13. Subordination Ratio: Mean Ratio of dependent to independent clauses in the written language samples obtained from each sex in each year of Years 3 through 5.

TABLE 10

Summary of Analyses of Variance:
Arithmetic Variables

Variable	Source of Variation	DF	Sum of Squares	Mean Square	F	Probability of a Larger F
Arithmetic Reasoning	Year	4	402.7423	100.6856	29.51	<.01
	Sex	1	10.6265	n.s.		
	Year and Sex	4	2.9297	n.s.		
	Within	776	2647.5654			
	Total	785	3063.8639			
Arithmetic Computation	Year	4	414.3129	105.5782	36.06	<.01
	Sex	1	3.9726	n.s.		
	Year and Sex	4	1.7542	n.s.		
	Within	774	2223.4589			
	Total	783	2643.4986			
Combined Arithmetic	Year	4	386.5925	96.6481	32.28	<.01
	Sex	1	7.0548	n.s.		
	Year and Sex	4	1.4508	n.s.		
	Within	775	2320.7378			
	Total	784	2715.8359			

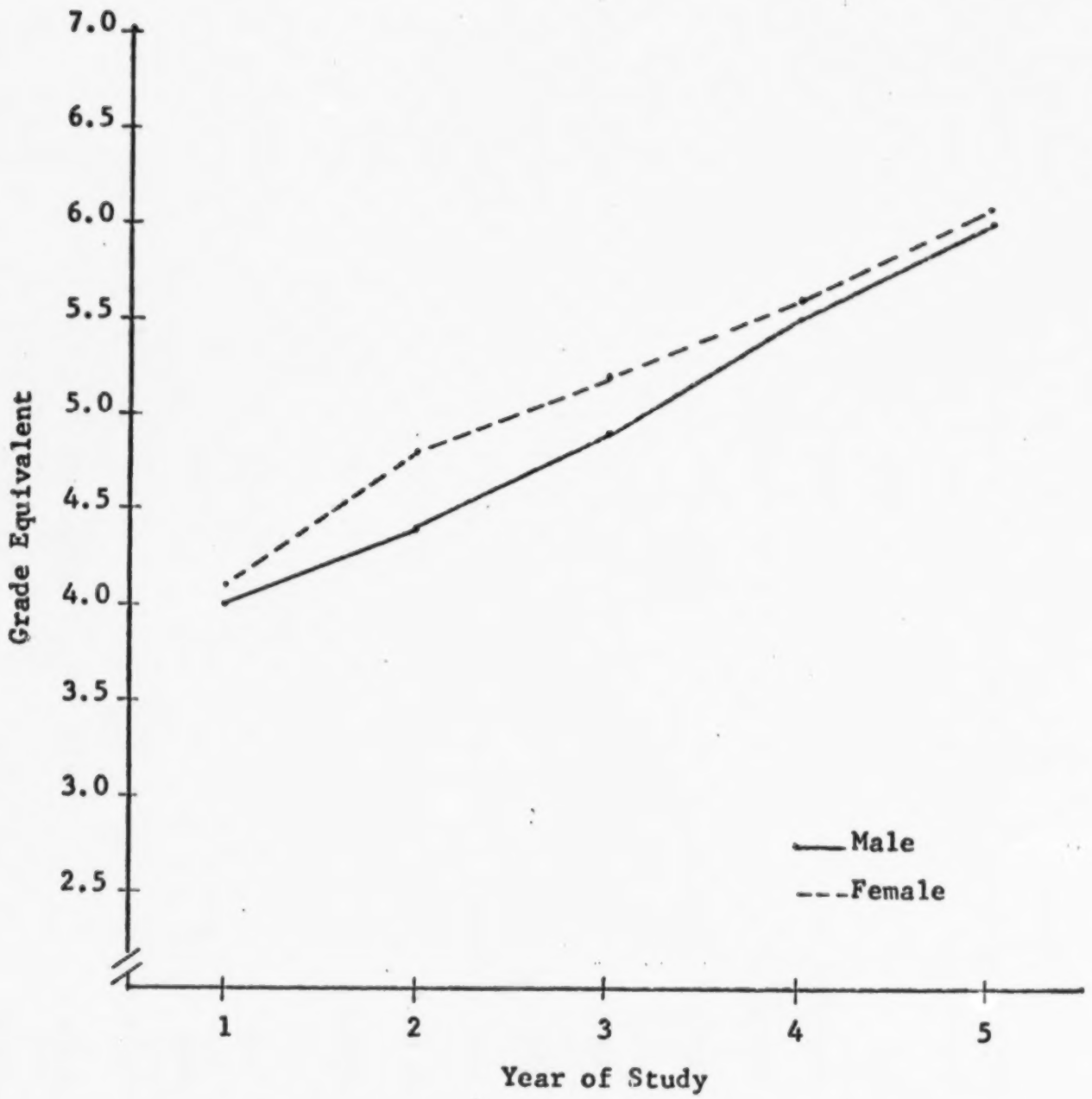

Figure 14. Combined Arithmetic: Mean grade equivalent scores in each year for each sex on the combined Arithmetic Reasoning and Arithmetic Computation sub-tests of the Stanford Achievement Test, Form N.

on Combined Arithmetic, the average arithmetic abilities of the subjects. It can be seen that while the females were slightly better than the males in average arithmetic ability, in no year was the difference significant. Both sexes improved significantly across the years in arithmetic abilities, but again this improvement must be considered to be an improvement only over the baseline performance in Year 1, for the total amount of gain in average arithmetic ability was only two grades, an average of one-half grade gain per year. It will be recalled that the females proved to be significantly better than the males in Combined Reading ability, and that the combined sexes improved significantly across the years in reading ability; however, the Battery Medians (Table 11 and Figure 15) indicate that only in Years 2 and 3 were there significant differences between the sexes in overall educational achievement as measured by the Battery Medians on the Stanford Achievement Test, and it is likely that these differences resulted from the superiority of the females on the Reading sub-tests.

As on the Combined Reading and on the Arithmetic variables, significant improvement was found for the combined sexes across the years on Battery Medians. This improvement, as can be seen from Table 2 again, amounted to a total increase of two grade levels -- or one-half grade per year. By the end of the study, the deaf students were nearly six full grades behind their non-deaf peers of similar ages in overall educational achievement. As might be expected, the smallest increase per year was found among the reading and language variables, for it is a truism that the impact of deafness falls heaviest on the ability to develop language skills. One cannot help but be struck, however, by the discrepancy between the performance of the average deaf subject in the study and that which would be expected of his non-deaf peer of the same age, for,

TABLE 11

Summary of Analysis of Variance:
Battery Median

Variable	Source of Variation	DF	Sum of Squares	Mean Square	F	Probability of a Larger F
Battery Median	Year	4	496.8398	124.2100	18.35	<.01
	Sex	1	22.5024	n.s.		
	Year and Sex	4	13.3927	n.s.		
	Within	777	5260.6135			
	Total	786	5793.3484			

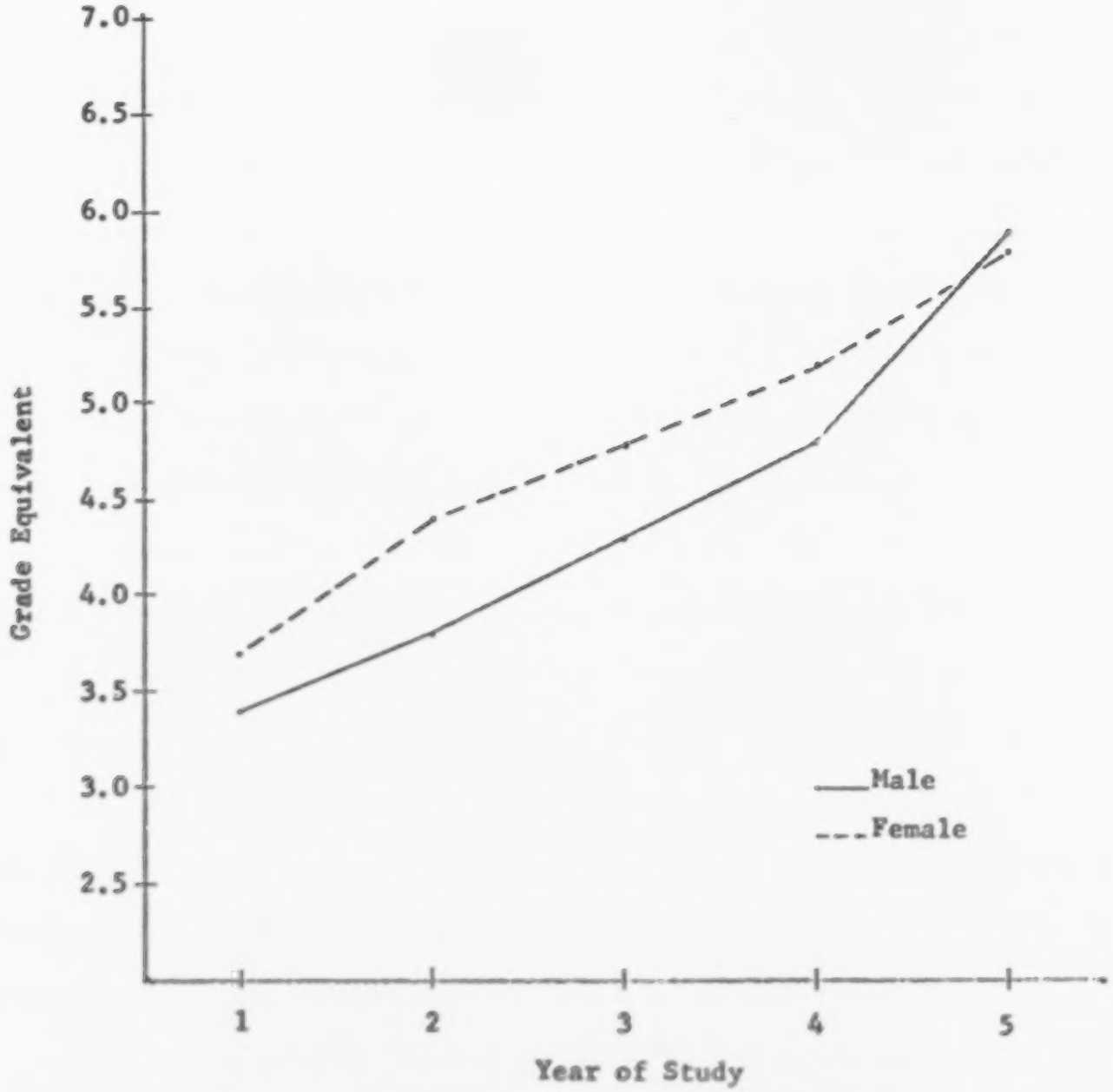

Figure 15. Battery Median: Mean grade equivalent scores in each year for each sex on the combined Reading, Arithmetic, and Language sub-tests of the Stanford Achievement Test, Form N.

insofar as the WISC or the WAIS can be considered valid instruments for measuring the intelligence of deaf students, the subjects of the study were of normal intelligence or above, so their relatively poor performance on the Standard Achievement Test did not appear to be the result of any lack of innate intelligence. The average IQ (Table 1) of the subjects in the study was, for the last four years of the study, 105.2, (S.D. 12.28), and when IQ was multiplied by Chronological Age (CA) and the product divided by 100, it was found that the average Mental Age (MA) was 0.7 years higher than the average CA. It would, therefore, appear that the subjects in the study were more intelligent than their performance on the Stanford test would seem to indicate.

While it was not possible to statistically identify any learning "plateaus" from the data in the study, Table 12 and Figure 16 illustrate the learning peaks and valleys which could be identified through visual inspection of the data. It can be seen from the Figure 16 that Year 2 was characterized by either average or maximum progress on most of the variables, while Year 3 was marked by a slowing down of the rate of progress to mostly average or below-average performance on most variables. Year 4 apparently was an either-or year, with the subjects' scores being distributed almost equally between worse-than-average, better-than-average, or average progress. In Year 5, mostly average performance was obtained on the largest percentage of variables, with smaller percentages of the scores showing minimum or maximum gains over the preceding year. Table 12 shows the years in which minimum and maximum progress were made on each variable in the study, and it can be seen that on the language variables, the most improvement occurred in either Year 2 or Year 4, and on the arithmetic variables, the most improvement occurred in Year 5, the last year of the study.

TABLE 12

Maximum and Minimum Gains and Year of Occurrence, by Variable:
Total Population

	Gains		Maximum Gain			Minimum Gain		
	Total	Average	Gain	Per cent	Year	Gain	Per cent	Year
Communication								
Fingerspelling	24.9	6.23	7.6	30.2	4	4.1	16.5	5
Speech	4.9	1.23	4.5	91.8	2	-0.8	(16.3)	4 * **
Speechreading								
Utley	0.7	0.35	2.4	343.0	3	-1.7	(243.0)	2 *
Craig word	7.2	2.40	2.7	37.5	2	1.9	26.4	5 *
Craig sent.	11.1	3.70	4.0	36.0	5	3.2	28.8	2
Language								
P.M.	1.4	0.35	0.5	35.7	2	0.2	14.3	4
W.M.	1.4	0.35	0.7	50.0	2	0.0	0.0	3
Comb. read.	1.4	0.35	0.4	28.8	2	0.3	24.1	3,4,5
Language	2.3	0.58	0.6	26.1	2	0.2	8.7	4
T.T.R.	4.7	1.18	2.5	53.2	4	-0.5	(10.6)	3
M.S.L.	2.7	0.68	1.1	40.7	2	0.4	14.8	4
Tot. words	45.0	11.25	38.1	84.4	2	-2.4	(5.3)	4
G.C.R.	4.2	1.05	4.1	97.6	4	-0.7	(16.7)	5
Strings	1.2	0.30	0.6	50.0	4	0.0	0.0	3
Sub. ratio	-2.7	-0.90	---	---	---	-2.0	(74.0)	5 *
Educ. Achievement								
A.R.	2.1	0.53	0.6	28.6	2.5	0.4	19.1	4 **
A.C.	2.1	0.53	0.6	28.6	4.5	0.4	19.1	3 **
Comb. arith.	2.0	0.50	0.6	30.0	5	0.4	20.0	3 **
Battery median	2.0	0.50	0.5	25.0	all	---	---	-- ***

*No significant growth (or decline) found between Years 1 and 5 for total population. (On all others, significant growth was found at .05 level or higher.)

**No significant differences found between sexes in any year. (Significant differences found at .05 level or higher on all others in at least one year.)

***No significant differences found between sexes in Year 5. (On all others, significant differences were found at .05 level or higher.)

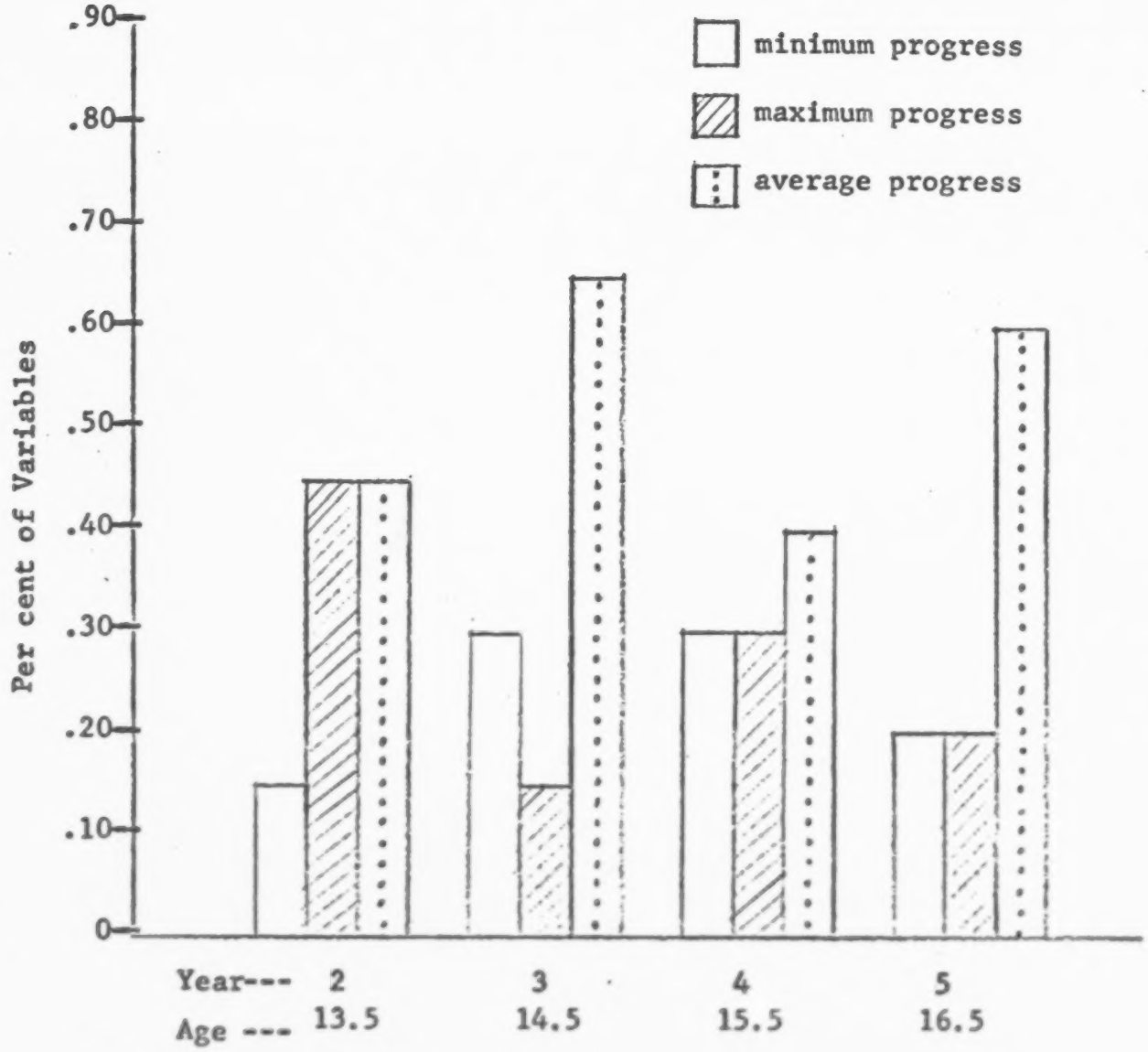

Fig. 16. Per cent of variables on which minimum, maximum, and average progress was noted in each year for the total sample population.

Correlational Analyses

Correlational matrices were obtained for each sex separately, and for the combined sexes for each year of the study. Tables 13, 14, and 15 give the matrices for all five years combined. In general, the correlation coefficients tended to be consistent (or to increase slightly) among the variables over the four years of the study, therefore the matrices for the combined scores for all five years can be considered to be representative of the interrelationships among the variables for each year. (An exception is Mental Age. The correlation coefficients given between MA and the other variables are for Year 2 only.)

Although some of the correlation coefficients appeared to be low, significance was found at or above the .05 level among many of the variables, and above .01 on some of the others. If the reader will examine the correlation matrices given in the three tables and use, as a rough index, the figure of r = .19 as the cut-off point above which significant relationships at the .05 level were found, and r = .35 as the point above which significant relationships at the .01 level were found, the degree of relationship found among the variables in the present study can more readily be recognized.

Among the variables, the lack of relationship between Speech Intelligibility and most of the descriptive variables was noteworthy. There was found to be no significant relationship between the ability to speak intelligibly and Age, Years of Previous Schooling, or Age at Onset of Deafness. Only in the case of Hearing Threshold Level (the amount of hearing loss) was a relationship found with Speech Intelligibility -- a low, but significant negative correlation -- with the data indicating that the more severe the hearing loss, the less intelligible was the speech.

TABLE 13

Correlation Coefficients Among Variables for All Five Years Combined:
Total Population (N = 163)

	Age	I.Q.	Y.P.S	Hear. loss	Age at onset	P.M.	W.M.	Comb. read.	Language	A.R.	A.C.	Comb.arith.	Batt.med.	Fingerspell.	L.R.,Utley	L.R.,C.W.	L.R.,C.S.	Speech	T.T.R.	M.S.L.	Tot. words	G.C.R.	Strings	Sub. ratio	Mental age
Age																									
I.Q.	.13																								
Y.P.S.	.82	.20																							
Hear. loss	.16	.07	.19																						
Age at onset	.05	-.09	-.06	.06																					
P.M.	.41	.34	.38	.18	-.01																				
W.M.	.34	.27	.31	.19	-.05	.76																			
Comb. read.	.41	.33	.39	.18	-.02	.99	.79																		
Language	.53	.35	.47	.20	.02	.88	.71	.88																	
A.R.	.56	.43	.53	.25	.01	.88	.71	.88	.89																
A.C.	.64	.37	.60	.27	.06	.82	.66	.83	.86	.95															
Comb. arith.	.60	.41	.57	.26	.03	.86	.69	.87	.88	.99	.99														
Batt. median	.44	.31	.39	.21	.07	.81	.66	.82	.78	.81	.78	.81													
Fingerspell.	.48	.27	.42	.26	-.03	.75	.62	.76	.80	.78	.74	.77	.67												
L.R., Utley	.32	.16	.36	.06	.00	.56	.53	.59	.54	.58	.56	.58	.49	.52											
L.R., C.W.	.17	.13	.23	.00	.00	.39	.36	.41	.34	.39	.38	.39	.30	.42	.62										
L.R., C.S.	.31	.23	.36	.03	.06	.60	.51	.61	.56	.60	.59	.61	.50	.59	.71	.79									
Speech	.10	.02	.00	-.19	.05	.36	.24	.36	.29	.29	.25	.28	.25	.26	.51	.50	.49								
T.T.R.	.26	.24	.27	.27	-.09	.53	.45	.57	.48	.57	.54	.56	.45	.58	.32	.39	.44	.14							
M.S.L.	.42	.18	.36	.11	.04	.69	.54	.71	.67	.69	.64	.67	.61	.64	.53	.35	.53	.45	.54						
Tot. words	.42	.22	.37	.16	-.08	.61	.54	.64	.60	.64	.65	.65	.61	.67	.44	.50	.57	.29	.68	.60					
G.C.R.	.29	.23	.23	.19	-.03	.64	.54	.65	.63	.62	.61	.62	.60	.65	.43	.55	.58	.36	.65	.55	.84				
Strings	.31	.25	.27	.11	.04	.81	.65	.81	.78	.74	.68	.72	.71	.70	.63	.49	.63	.50	.47	.81	.62	.76			
Sub. ratio	.24	.14	.21	.07	.06	.53	.40	.54	.49	.45	.40	.43	.48	.42	.26	.10	.29	.22	.30	.54	.33	.23	.48		
Mental age[1]	.77	.72	.70	.20	.15	.50	.17	.54	.46	.71	.73	.74	.63	.53	.25	.27	.35	.13	.10	.34	.40	.29	.29	--	

[1] Mental age correlation coefficients for Year 2 only.

TABLE 14

Correlation Coefficients Among Variables for All Five Years Combined:
Males (N = 83)

	Age	I.Q.	Y.P.S.	Hear. loss	Age at onset	P.M.	W.M.	Comb. read.	Language	A.R.	A.C.	Comb.arith.	Batt.med.	Fingerspell.	L.R.,Utley	L.R.,C.W.	L.R.,C.S.	Speech	T.T.R.	M.S.L.	Tot. words	G.C.R.	Strings	Sub. ratio	Mental age
Age																									
I.Q.	.09																								
Y.P.S.	.79	.17																							
Hear. loss	.04	.10	.09																						
Age at onset	-.07	-.24	-.17	-.03																					
P.M.	.51	.33	.43	.09	-.10																				
W.M.	.50	.25	.42	.07	-.10	.94																			
Comb. read.	.52	.30	.43	.07	-.11	.99	.98																		
Language	.53	.31	.45	.14	-.12	.89	.84	.88																	
A.R.	.61	.39	.55	.18	-.14	.89	.86	.89	.89																
A.C.	.68	.28	.60	.18	-.07	.86	.85	.86	.84	.95															
Comb. arith.	.65	.35	.58	.18	-.11	.89	.87	.89	.88	.98	.99														
Batt. median	.42	.21	.30	.11	-.01	.69	.71	.71	.64	.67	.65	.67													
Fingerspell.	.51	.27	.44	.22	-.12	.79	.76	.79	.84	.81	.76	.80	.60												
L.R., Utley	.41	.15	.38	.00	.00	.67	.66	.68	.61	.61	.64	.63	.45	.56											
L.R., C.W.	.24	.17	.29	-.17	-.05	.40	.42	.42	.35	.39	.42	.41	.24	.39	.61										
L.R., C.S.	.42	.26	.43	-.10	.05	.60	.59	.61	.55	.60	.61	.61	.41	.56	.70	.81									
Speech	.19	.06	.03	-.30	.00	.54	.51	.55	.46	.37	.35	.37	.30	.38	.65	.57	.60								
T.T.R.	.24	.26	.25	.19	-.07	.50	.56	.54	.47	.56	.55	.56	.35	.57	.27	.37	.42	.19							
M.S.L.	.43	.11	.36	.03	-.11	.64	.66	.66	.60	.61	.56	.59	.46	.62	.45	.31	.47	.52	.57						
Tot. words	.45	.23	.34	.07	-.10	.65	.68	.67	.60	.67	.68	.69	.60	.66	.41	.45	.55	.34	.71	.61					
G.C.R.	.31	.25	.21	.12	.01	.65	.66	.67	.62	.63	.62	.63	.56	.65	.43	.56	.61	.45	.63	.53	.85				
Strings	.31	.20	.21	.05	.00	.76	.74	.76	.74	.68	.62	.66	.58	.71	.62	.54	.63	.69	.44	.75	.66	.80			
Sub. ratio	.18	.22	.14	.12	-.10	.47	.46	.48	.41	.39	.33	.36	.42	.39	.23	.03	.12	.25	.30	.49	.26	.17	.39		
Mental age[1]	.78	.69	.70	.12	.01	.62	.60	.63	.44	.73	.73	.75	.66	.56	.31	.32	.41	-.14	-.07	.26	.46	.26	.24	--	

[1] Mental age correlation coefficients for Year 2 only.

TABLE 15

Correlation Coefficients Among Variables for All Five Years Combined: Females (N = 80)

	Age	I.Q.	Y.P.S.	Hear. loss	Age at onset	P.M.	W.M.	Comb. read.	Language	A.R.	A.C.	Comb.arith.	Batt.med.	Fingerspell.	L.R.,Utley	L.R., C.W.	L.R., C.S.	Speech	T.T.R.	M.S.L.	Tot. words	G.C.R.	Strings	Sub. ratio	Mental age
Age																									
I.Q.	.17																								
Y.P.S.	.83	.23																							
Hear. loss	.25	.05	.28																						
Age at onset	.19	.04	.08	.08																					
P.M.	.32	.37	.34	.24	.10																				
W.M.	.25	.31	.26	.26	.02	.68																			
Comb. read.	.32	.39	.36	.27	.09	.99	.72																		
Language	.52	.43	.49	.26	.22	.86	.64	.87																	
A.R.	.51	.48	.51	.31	.19	.88	.67	.89	.92																
A.C.	.59	.46	.59	.36	.24	.81	.61	.82	.90	.96															
Comb. arith.	.56	.47	.55	.34	.22	.85	.65	.86	.92	.99	.99														
Batt. median	.47	.45	.48	.31	.20	.94	.69	.95	.95	.97	.94	.97													
Fingerspell.	.45	.31	.40	.32	.11	.72	.56	.73	.77	.75	.73	.75	.76												
L.R., Utley	.23	.18	.34	.11	.00	.46	.47	.51	.47	.55	.49	.53	.53	.47											
L.R., C.W.	.05	.12	.14	.19	-.04	.36	.33	.38	.27	.38	.33	.36	.36	.40	.66										
L.R., C.S.	.16	.25	.26	.17	.12	.59	.48	.61	.53	.61	.57	.60	.61	.59	.73	.76									
Speech	-.02	-.04	-.03	.07	.12	.21	.10	.21	.16	.21	.11	.17	.20	.12	.41	.42	.38								
T.T.R.	.27	.23	.30	.37	-.09	.58	.43	.61	.50	.57	.54	.56	.57	.59	.37	.42	.46	.08							
M.S.L.	.40	.26	.36	.19	.25	.76	.53	.78	.77	.78	.73	.77	.81	.69	.62	.42	.62	.36	.51						
Tot. words	.39	.26	.41	.27	-.03	.58	.50	.61	.59	.62	.62	.62	.61	.67	.47	.55	.57	.24	.63	.60					
G.C.R.	.26	.25	.25	.28	-.04	.64	.50	.64	.63	.62	.61	.62	.64	.63	.40	.47	.48	.23	.68	.58	.81				
Strings	.30	.31	.32	.17	.12	.82	.60	.84	.80	.79	.73	.77	.84	.67	.63	.43	.61	.35	.50	.90	.58	.72			
Sub. ratio	.29	.11	.26	.04	.23	.55	.35	.57	.52	.50	.45	.48	.54	.42	.26	.15	.42	.22	.31	.59	.39	.27	.52		
Mental age[1]	.77	.75	.70	.27	.28	.42	.15	.49	.49	.70	.73	.74	.62	.51	.20	.21	.29	.12	.38	.39	.37	.32	.32	--	

[1]Mental age correlation coefficients for Year 2 only.

Two other variables, Hearing Threshold Level, and Age at Onset of Deafness, also showed few significant relationships with the other variables and, to a degree, the same held true of the data from the Utley Test of Lipreading, and the Word Version of the Craig Lipreading Inventory. Of all the communication variables, only Fingerspelling Ability and the Sentence Version of the Craig test showed consistently significant relationships with the other experimental variables, with the relationships showing higher significance in the case of Fingerspelling Ability than for Speechreading ability as measured by the Craig Sentence test.

Table 16 gives the major factors which were extracted from the correlation matrix in Year 2 (the year in which the most complete data were obtained), and Table 17 shows the per cent of variance in the data accounted for by the various factors. It can be seen that one factor accounted for over 24 per cent of the total variance, with the remaining variance distributed among the other 14 factors, with each having only a small amount of the total variance. As in the original study reported on by Quigley (1969), the major factor appears to involve the language and communication skills. It will be noted that all sub-tests of the Stanford Achievement Test except Word Meaning loaded heavily on this factor, and it can be seen from Table 13 that the intercorrelations of all sub-tests of the Stanford were high. It would appear, therefore, that the Stanford Achievement Test was measuring mostly the language ability of the subjects, rather than their educational levels, and raises some questions about the feasibility of using a test standardized on non-deaf students, who presumably are not handicapped by language deficiencies, as a measure of educational achievement for deaf students in view of the acknowledged difficulty experienced by deaf students in acquiring language.

TABLE 16

Varimax Rotated Factor Matrix for Year 2 (1964): Combined Sexes (N = 163)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age	.68	.14	-.24	.19	.16	-.05	.34	-.04	-.26	.13	.31	.14	-.02	-.06	-.02
I.Q.	.41	.23	-.10	.04	.08	.07	.30	.12	.52	-.14	-.54	-.05	.15	.07	-.05
Y.P.S.	.64	.02	-.36	.21	.25	.13	.27	-.09	-.19	-.01	.26	.11	-.05	-.00	.06
Hearing Threshold Level	.07	.57	-.69	-.11	.10	-.10	-.38	.08	.01	-.07	.02	.01	.02	-.06	.01
Age at Onset	.06	.08	-.10	-.04	.15	-.42	.20	.33	-.05	.19	-.37	-.13	.17	.15	.10
Paragraph Meaning	.82	.12	.20	-.13	-.05	.04	-.07	-.16	.07	.01	-.06	-.14	-.20	-.00	-.02
Word Meaning	.24	.08	-.07	-.10	-.06	.05	-.06	.06	.38	.58	.34	-.38	.16	.24	.15
Combined Reading	.87	.14	.21	-.14	-.03	.06	-.05	-.16	.04	-.01	-.01	-.13	-.13	-.00	-.03
Language	.73	.31	.34	-.14	.19	-.11	-.05	-.12	-.09	-.09	-.06	-.21	-.04	-.06	.05
Arith. Reasoning	.91	.19	.02	-.06	.09	.04	.08	-.15	.05	.07	-.04	.06	-.08	.07	-.06
Arith. Computation	.89	.11	-.06	-.03	.13	-.03	.14	-.16	-.00	.09	.00	.13	-.03	.08	-.01
Combined Arith.	.92	.16	-.01	-.04	.11	.00	.11	-.16	.03	.08	-.02	.10	-.06	.07	-.04
Battery Median	.92	.19	.16	-.12	.02	.01	.03	-.13	-.01	-.03	-.02	-.06	-.08	.06	-.02
Fingerspelling	.80	.19	.11	.04	-.16	.28	-.10	.05	-.07	-.00	-.01	-.05	.10	-.12	.01
L.R. Utley	.63	-.22	.18	-.35	.10	-.01	-.23	.09	.17	.05	.20	.15	.25	-.07	.04
L.R. Craig Word	.57	-.55	.03	-.08	.05	-.10	-.05	.17	.09	.02	-.03	.13	.19	-.13	.15
L.R. Craig Sentence	.65	-.33	.12	-.16	.07	-.06	-.08	.21	.14	-.02	.08	.24	.15	-.05	.07
Speech	.48	-.44	.19	-.21	-.10	-.18	-.17	.26	-.05	.00	-.06	.15	.04	.14	-.04
Type Token Ratio	.14	.14	.24	-.63	.39	.14	.08	.18	-.10	.08	-.07	-.05	-.01	-.40	.10
Mean Sentence Length	.62	-.06	.15	-.06	.18	.01	-.18	.06	-.17	-.31	.14	-.15	.24	.26	-.33
Total Words Written	.54	-.29	-.17	.69	-.11	-.04	-.03	.14	.04	-.04	.04	-.14	.01	-.08	-.05
Grammatical Corr. Ratio	.64	.04	.18	.00	-.39	-.10	-.16	.14	-.13	-.10	-.01	.06	-.28	-.01	.16
Strings Analysis	.71	.02	.26	-.11	-.23	-.08	-.28	.10	-.16	-.27	.03	-.01	.01	.19	.01
Mental Age	.72	.25	-.23	.14	.17	.01	.44	.05	.14	.01	-.13	.07	.09	.01	-.04

TABLE 17

Factors Tapped by Measuring Devices

Factor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Per Cent Variance	24.36	9.06	8.26	8.18	7.62	6.76	6.01	5.05	4.75	4.06	3.77	3.31	3.26	3.03	2.52

Summary and Discussion

The present study was essentially a reexamination of the data collected by Quigley (1969) during a four year study of the influence of fingerspelling on the communication abilities, language abilities, and educational achievement of deaf students in six residential schools for the deaf. The purpose of the present study differed from the original in that no attempt was made to categorize the results in terms of the method of instruction used with the subjects as was done in the original study. Rather, the main focus of the present study was to ascertain, if possible, overall growth patterns and rates of improvement for all subjects combined, as well as the influence of sex on performance. The hypotheses of the present study were:

1. There would be significant changes in growth rate for both sexes, and for both sexes, and for the combined N across the four years of the study.

2. There would be significant differences between the sexes on most of the experimental variables throughout the study.

The procedures followed in the present study were those described by Quigley (1969) insofar as selection of the subjects, measurement of the experimental variables, collection, and recording of the data were concerned. Only the methods of statistical analysis differed, in that the present study employed analyses of variance (rather than t-tests) to compare the performance of the subjects across the years, and the subjects were dichotomized by sex, rather than by method of instruction.

The results of the study indicated that: (1) Both sexes as well as the combined N showed small but significant improvement across the years on all variables with the exception of three: (a) Speech Intelligibility; (b) one

measure of Speechreading Ability, (the Utley Test of Lipreading, which was discontinued after Year 3); and (c) language complexity as measured by the Subordination Ratio in the last three years of the study. On the latter three variables, no significant improvement was found between Years 1 and 5 (Years 3 - 5 on Subordination Ratio), nor among any of the intervening years. (2) The females were consistently better than the males in Speechreading ability, Fingerspelling ability, Reading ability, and, to a degree, in Language ability; the males had slightly better speech than the females although not significantly better; and the sexes did not differ significantly in overall educational achievement by the time the study ended. (3) Significant relations were found among many of the variables, particularly between the ability to understand fingerspelling, and performance on most of the experimental variables. Noteworthy was the lack of any significant relations between the intelligibility of the subjects' speech and their IQ levels, their age, the amount of previous training they had received, or the age at which they suffered hearing impairment.

Overall educational achievement as measured by the Stanford Achievement Test indicated that the subjects began the study four full grades behind non-deaf subjects of comparable ages, and thereafter advanced at the rate of one-third to one-half grade per year, with Reading and Language achievement scores advancing at a lower rate than the Arithmetic achievement scores.

In terms of the first hypotheses of the present study, significant changes in the <u>amount</u> of growth were found across the four years of the study on all but the previously mentioned three variables -- Speech Intelligibility, Speechreading as measured by the Utley Lipreading Test, and Subordination Ratio -- but, due to small fluctuations in numbers of subjects in each year

(a result of normal absenteeism on testing days), it was not possible to determine whether the peaks and valleys in the various learning curves represented statistically significant deviations from linearity. On some variables, the learning curves showed steady growth. On others, there were definite peaks and valleys, indicating spurts of learning activity intermixed with periods where growth seemed to cease or actually dip below the previous year's norm, or perhaps just chance fluctuations. On still others, nearly flat curves indicative of minimum progress were noted. The only general conclusion to be made from examining the data is that, in almost all cases, the females were superior to the males whether or not the differences were significant, and on most variables, significant differences were found between the sexes, lending support to the second hypothesis of the study -- the hypothesis which predicted such differences would be found.

It must be kept in mind when discussing the results of the study that any statistically significant improvement in performance found on the experimental variables is relevant only to the sample population studied. In most cases, the subjects improved on their own baseline performances as measured by their test performances in Year 1, and, in general, this improvement was seen in each succeeding year. However, when the amount of improvement shown by the subjects in the study on the Stanford Achievement Test Scores is compared with the Stanford Test Norms, it can be seen that the improvement, while significant in terms of the subjects' baseline performance, was only one-third to one-half that which would be expected of average non-deaf students of comparable ages.

If one studies the data in the Gentile (1969) report, and averages the Paragraph Meaning, Language, and Total Arithmetic percentages given in that

study across the 16- and 17-year age brackets for subjects with 60 decibel hearing losses or above, one will obtain a rough index of the battery medians in the Gentile study which can be compared with the battery medians found in the present study. It will be seen that 52 per cent of the subjects in the Gentile study fell within the 5.5 to 5.9 grade level or below, which indicates that the data from the present study were consistent with the Gentile data, for the battery medians in the present study indicated that subjects of 16.5 years of age had achieved a grade equivalent of 5.5. The data in the present study are also consistent with the findings of other investigators, who reported that the median grade for deaf students of high-school leaving age generally falls somewhere between the third and seventh grades.

The mean IQ of the subjects in the study was slightly skewed in that there were more subjects in the superior and bright-normal categories (IQ of 120 or better) than fell in the dull-normal classification (IQ of 80 to 95), which would appear to rule out lack of innate intelligence as a factor contributing to the relatively poor performance of the deaf subjects in the study when compared with non-deaf students.

The conclusion to be drawn from the present study is that there was a definite relationship between sex and achievement among the deaf students insofar as language and communication abilities were concerned. Only in overall educational achievement as measured by the battery medians of the Stanford Achievement Test were there similarities between the growth patterns of deaf and non-deaf students in that early differences in favor of the females had disappeared by the time the early adolescent period was past and the males began to catch up.

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